

Doc. 2GJA708755  
Rev. A 03/2013 [LM]  
PASS M0

Operation and maintenance manual

# **PASS M0 123-170 kV Operation and maintenance Manual**



# PASS M0 123 - 170 kV

## Doc. 2GJA708755

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# PASS: Innovative Solutions for Distribution Substations



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# 1. Important Information

## 1.1 Supplier's / Manufacturer's Address

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## 1.2 Contact Address

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## 1.3 Purpose of this Manual

This manual describes high-tech high voltage products, and is specifically aimed at explaining the use of such products. These instructions are not meant to replace valid regulations, concerning high voltage systems and appliances, and are intended for use by specialists in the electricity field.

## 1.4 Safety Note



Activities described under “Maintenance” must only be carried out from our Personnel or from Personnel trained by us when the notes have been read and understood and the preconditions described there fulfilled.

Otherwise, the manufacturer shall not be liable for damage of any kind as a result of improper handling.

# 2. Glossary

## 2.1 Abbreviations

- PASS Plug And Switch System
- SBB Single Bus Bar
- DBB Double Bus Bar
- IOS Incoming Outgoing Substation
- DCB Double Circuit-breaker
- LCC Local Control Cabinet
- OSCAR Optimal Substation Concept And Research
- SLD Single Line Diagram

## 2.2 Symbology



**Information**



**Mechanical Operation**



**Warning Information**



**DANGER:** Information indicating that danger or risk exists which could result in serious or fatal injuries to personnel.

## 3. Concept



**NOTE: This document provides general information which does not take into consideration specific project requirement. Please refer to specific project schematics for the working and interlock principle of the equipment.**

PASS is equivalent to a high voltage bay. In PASS all live parts, excluding Bus Bars and CT's, are encapsulated in a grounded aluminium tank which is filled with pressurised SF6 gas. Each pole has its own enclosure to increase availability and safety. The main enclosures are made of cast aluminium. Using standard components, the addition of a secondary Bus Bar system to PASS is straightforward.

## 4. Flexibility

PASS (Plug And Switch System) is based on ABB extensive experience in manufacturing both air insulated switchgear (AIS) and gas-insulated switchgear (GIS). PASS can also be thought as "Performance And Save Space": any substation layout can be met while making efficient use of available space. Performance is guaranteed by the wealth of experience in research and development, manufacture and operation of switchgear which constitute the basis of ABB know-how. The key characteristic of PASS is its compact and modular design which encompasses several functions in one module, as for example:

- Bushings for connection to one or two Bus Bar systems;
- One or two circuit-breakers
- One or more combined disconnectors/earthing switches;
- One or two current transformers
- Complete H Configuration S/S

### PASS M0

The PASS M0 is a complete High Voltage substation in incoming/outgoing configuration:

- primary bushings are connected to the power transformer;
- secondary bushings are connected to the outgoing line;
- tertiary bushings are connected to the incoming line.

Therefore there is no traditional Bus Bar, i.e. the Bus Bar is realized within the PASS M0 by means of the first and second bushings. PASS in this configuration is a really breakthrough as system concept (patented) for distribution substation. It may have the following configuration:

- Single Bus Bar (SBB)
- Double Bus Bar (DBB)
- In and Out substation (IOS)
- Double Circuit Breaker (DCB)
- H Configuration

### PASS M00

PASS M00 has been designed to meet the specific requirements of the fast-expanding market for 72,5 kV and 100 kV systems.

### PASS M0S

PASS M0S is born from experience that ABB Group has gained in the field of hybrid modules (PASS M0), to cover market request for transmission and distribution substations at 252 kV.

The innovative characteristic of PASS M0S is a three-position disconnected, which allows sectionalising and earthing through one moving contact. PASS M0S has been realised as modular component with basic standard functions, which can be increased according to other requirements of the



PASS M00



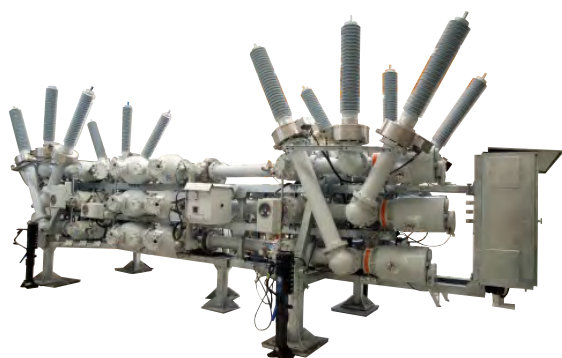
PASS M0



PASS M0S



PASS M0S 50kA



PASS M0H

		PASS M00 PASS M00H		PASS M0 PASS M0H			PASS M0S	PASS M0S 50 kA
Rated Voltage	kV	72,5	100	123	145	170	245	245
Rated Current	A	2000		3150			3150	3150
Breaking Current	kA	40	20	40			40	50
AC Test Voltage	kV	160	185	230	275	325	395	460
Impulse Test Voltage - BIL	kV	350	450	550	650	750	950	1050
Altitude Above Sea	m	≤ 1000		≤ 1000			≤ 1000	≤ 1000
Max air Temperature	°C	+ 40 (1)		+ 40 (1)			+ 40 (1)	+ 40 (1)
Min air Temperature	°C	- 30 (1)		- 30 (1)			- 25 (1)	- 35 (1)
Relative humidity	%	100		100			100	100
Wind pressure	Pa	700		700			700	700
Sun radiation	W/m2	≤ 1000		≤ 1000			≤ 1000	≤ 1000
Earthquake (IEC1166)	g	0.5		0.5			0.5	0.5
Protection deg. (IEC 60529)	IP	44 (2)		44 (2)			44 (2)	44 (2)
Pollution Level (IEC 60137)		III Heavy (3)		IV Very Heavy			IV Very Heavy	IV Very Heavy

(1) different temperatures on request

(2) different degree on request

(3) level IV (Very Heavy) on request

## 4.1 Integration with secondary system

PASS is equipped with conventional coupling towards the external substation process: e.g. auxiliary contacts for circuit-breaker and disconnector/earthing switch position and relay's contacts for signalling (e.g. SF6 leak). This conventional interface allows the PASS to be connected with any control and protection system, thus enabling retrofitting and upgrading of already existing substations.

## 5. Environmental Impact

PASS is kind to the environment. Global life cycle cost and impact on the environment were considered during PASS design right from the beginning. Compared to a conventional air insulated solution which implements the same functions, PASS meets the following targets:

- SF6 reduced by 80%;
- maintenance cost reduced by 38%;
- space reduced by 70%;
- total life cycle cost 60% lower;

Compared to a conventional 5 bays H layout air insulated substation, the global life cycle cost for PASS is estimated to be more than 30% lower.

Moreover PASS has been subjected to the LCA (Life Cycle Assessment), a study that covers all environmental aspects during the whole life of the product. In this regard, EDP (Environmental Product Declaration) provides a quantitative and verified description of the environmental performance of PASS, viewed from a comprehensive life cycle perspective.

## 6. Quality Assurance

Design, material, suppliers, sub-assemblies and working procedures are ruled by internal quality assurance programs, which meet the requirements stated by ISO 9001 and 14001.

Parts which are not directly manufactured are provided by other ABB companies or by approved vendors. A test plan states the regular incoming material inspection. Disruptive and non-disruptive special tests are performed in our, or at third part, laboratories where we verify the conformance to the technical specification.

All instruments and apparatus used for testing and checking are systematically and periodically calibrated in our metrological laboratory or at qualified third party labs. Standard operation procedures are the basis to ensure the correct assembling process.

The documents provide step-by-step assembly instructions for each part of our product

All check lists, filled at assembling and test step, are collected and stored, to ensure the whole traceability of products and sub-assemblies.

The final tests prove the conformity of the product to Client specifications and to the applicable International Standards. The completeness of the supply is one by one confirmed by a Final check.

## 7. Manufacturing

PASS manufacturing process is mostly based on techniques like Lean Manufacturing and Theory Of Constraints. The "Assembly To Order" model is used to guarantee the traceability of all subcomponents.

Major targets like On Time Delivery are achieved thanks to the modularization of the product and relevant standardization of sub-components, allowing a smooth supplying and assembling process.

No stock is then needed, neither for sub-components not for finished products.

Technical features like special automatic tools for the subcomponents assembling, fast reconfigurable production lines and tool carts for sub-assemblies handling make the factory flexible enough to adapt itself to the always changing needs and demands from the market.

## 8. Transportation

No special arrangements are needed for shipping and transportation. PASS, in its standard version, fits in a standard truck container and does not require special packaging. On receipt of the good, the entire module PASS and structure shall be checked; in particular the density switches the drives of the circuit breaker and disconnect. The equipment shall show no sign of break or tampering. If any problems are found the Shipping office of ABB S.p.A. PPD U.O. Adda shall be immediately informed. Once on site a simple 30° rotation of the outer poles is needed for the final layout of PASS (Not needed for H configuration module). If the equipment is stored before assembly, it must be kept in a covered, dry place. If this equipment is stored outside, it must be placed in a dry drained place and all packages must be covered with tarpaulins. The integrity of the packages and their covers must be checked periodically (ref. to STORAGE instruction 2GJA708375).

PASS switchgear is produced according to the following standards:

- For pressure vessel construction: .....CENELEC EN 50052
- For quality assurance: .....ISO 9001, 14001

For switchgear and associated equipment:

- High voltage switchgear.....IEC 62271-1
- Compact switchgear assembly.....IEC 62271-205
- SF6 switchgear.....IEC 62271-203
- Bushings.....IEC 60137
- Current transformers.....IEC 60044-1
- Disconnect/earthing switch.....IEC 62271-102
- Circuit-breaker.....IEC 62271-100

## 9. On-site Assembly

A PASS module is equivalent or almost equivalent to a complete bay or S/S.  
It allows the installation of substations in a short period of time: each bay can be unloaded from the trailer and directly installed on the platform foundation.  
The on-site erection of PASS modules is simplified since PASS is fully assembled in the factory before shipment.  
The installation of a PASS requires few hours with a crew of two (not including gas handling).

## 10. Standard

PASS meets the requirements set out in the following documents:

- IEC (all relevant standards - see technical data)
- ISO 9001 and 14001.

The enclosure complies with the following standard for pressure vessels:

- CENELEC EN 50052.

Quality handbooks and inspection plans can be provided to the customer on request.

# 11. Pass variants

Thanks to the modular approach, the number of possible variants is extremely high; the following list reports just some of the possible solutions.

<ul style="list-style-type: none"> <li>PASS M00 SBB</li> <li>PASS M00 DBB</li> <li>PASS M00H</li> </ul>	<ul style="list-style-type: none"> <li>PASS M0 SBB</li> <li>PASS M0 DBB</li> <li>PASS M0 DCB</li> <li>PASS MOH</li> </ul>	<ul style="list-style-type: none"> <li>PASS M0S SBB</li> <li>PASS M0S DBB</li> <li>PASS M0S DCB</li> </ul>
<ul style="list-style-type: none"> <li>PASS M00 Cable ends</li> </ul>	<ul style="list-style-type: none"> <li>PASS M0 (SBB, DBB or DCB)                             <ul style="list-style-type: none"> <li>with GIS VT's</li> <li>with cable ends</li> <li>with additional CT's</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>PASS M00 Mobile Substation</li> </ul>	<ul style="list-style-type: none"> <li>PASS M0 Mobile Substation 115/34,5 kV – 30 MVA</li> <li>PASS M0 Mobile Substation 132/20 kV – 25 MVA</li> <li>PASS M0 Railway Mobile Substation</li> </ul>	
	<ul style="list-style-type: none"> <li>PASS M0 IOS</li> </ul>	

## 12. Tests

### 12.3 On-site testing

#### 12.1. Type tests

All type tests specified by the relevant IEC standards have been passed. Tests can be repeated on request at customer's expense. Copies of certificates and reports can be provided on request.

#### 12.2. Routine tests

Before leaving the factory all PASS units are subject to the following routine tests:

- dielectric tests on auxiliary control units;
- pressure tests of the enclosure according to CENELEC-EN 50052 1986 TC 17C WG MPE. The enclosure is tested at double the design overpressure for one minute. This test also meets the requirements of IEC 62271-203;
- gas tightness;
- mechanical functional test of all moving parts;
- test of all equipment and accessories;
- AC high voltage test. These tests ensure perfect functionality of all components before they leave the factory. A test report is produced for all tests.

On request customers can attend the final acceptance test session.

- After final assembly or commissioning of the substation, the following tests are done:
- mechanical functional testing of circuit-breaker, and combined disconnector/earthing switch;
  - testing of SF6 gas-tightness;
  - random sampling of moisture content in individual components;
  - checking and functional testing of control and auxiliary equipment.
- After completion of these tests a handover report is completed.

## Notes

If you have some comments we kindly ask You to write that here below and send us this page back.  
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# PREVENTIVE MAINTENANCE GUIDE FOR PASS

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# 1. Preventive Maintenance Guide

- The operational safety of the PASS main components CB, DS, ES, CT, is not affected by any external impact (such as dirty, humidity, etc.) with the exception of the bushings.
- Bushings are qualified for use in polluted environment and in presence of rain. PASS module requires no maintenance for a long time.

The prescribed activities are:

- periodical inspections
- preventive maintenance
- revision

## 1.1 Periodical inspection

Functional and visual inspections are carried out without opening the gas compartments.  
Every year a visual inspection (with the module in service) of the following parts is recommended:

- bushings
- SF6 density device and relevant indication;
- number of circuit breaker operations;
- tightness of Local Control Cabinet door gaskets;
- general check of the compartments: position indicators, connectors, cables, equipotential connections, earthing circuit. None of the auxiliary equipment shall be worn or overheated and no vibration shall harm the relays.

At the end of the first year we recommend to retighten screw joints related to anchor bolts and earthing connection and check the absence of corrosion or deterioration of components.



**NOTE: in case of daily breaker operations, all wirings shall be checked, of LCC and BLK (82-222) drive (if present). The check must be done every two years.**

Inspection type	Timing / tools / personnel	Instructions
Visual inspection of bushing	Every year No Tools needed Unskilled personnel	Standing on land check on all sides the condition of sheds
Check of SF6 density device	Every year Tools needed: reference values on Schematic Diagram Unskilled personnel	Record the value seen on the device and compare it with the reference value
Recording the number of circuit breaker operations	Every year No Tools needed Unskilled personnel	Record the number of circuitbreaker operations reported on counter located on LCC
Tightness of door gaskets	Every year No Tools needed Unskilled personnel	Open the door of LCC and check the gasket condition

General check of the components	Every year No Tools needed Unskilled personnel	Check position indicators, connectors, cables, equipotential connections, earthing circuit. None of the auxiliary equipment must be worn or overheated and shall no vibration harm the relays.
Retighten screw joints related to anchor bolts and earthing connection	End of the first year Tools needed: torque wrench, module layout Unskilled personnel	Check the tightness of anchor bolts and earthing connection and retighten if necessary.

Table 1

## 1.2. Preventive maintenance

The preventive maintenance activities of the PASS are carried out with the module out of service. It shall be done if one of the following conditions is reached:

- after 5000 mechanical operations
- when the number of short-circuits is approaching the listed values:
- after 20 years of service.
- 

The preventive maintenance is carried out with the replacement of PASS module with one previously reconditioned in order to reduce the outage time. Complete module revision and replacement of worn part is made.

### For the Pass M00

N° (number of operations)	3000	1200	160	40	20	10	8	5
I [kA] Current	1.25	2	5	10	15	20	25	31.5

### For the Pass M0 - M0S 40 kA

N° (number of operations)	5000	800	200	89	50	32	20	13	9
I [kA] Current	2	5	10	15	20	25	30	35	40

### For the Pass M0S 50 kA

N° (number of operations)	5000	800	200	50	22	12	8
I [kA] Current	2	5	10	20	30	40	50

Table 2

Inspection type	Timing / tools / personnel	Instructions
Check of alarms, trips and blocks and check of pressure gauge condition	Every 20 years Tools needed: SF6 gas bottle, pressure gauge Skilled personnel or personnel certified by ABB Adda Service at level 2	Check the alarm and trip/block threshold by decreasing the pressure and by comparing relevant values with the reading of the sample gauge previously connected. <b>NOTE: be aware that the density switch supplied with the module is temperature compensated (at 20°C): for comparison please refer to the conversion table in the SF<sub>6</sub> gas system manual</b>
Check moisture level in the SF6 Compartments	Every 20 years Tools needed: hygrometer Skilled personnel	Connect the hygrometer to the PASS filling valve type DN8 and check the humidity value is within the allowed range (please refer to the Gas Manual).

Inspection type	Timing / tools / personnel	Instructions
Check lubrication of gear box of disconnecting switch drive and inspect covers gaskets tightness	Every 20 years No tools needed Skilled personnel or personnel certified by ABB Adda Service at level 1	Refer to the "MAINTENANCE" paragraph of specific components
Check lubrication of circuit breaker drive mechanism and inspect covers gaskets tightness	Every 20 years No tools needed Skilled personnel	Refer to the "MAINTENANCE" paragraph of specific components
Repetition of commissioning mechanical test	Every 20 years Tools needed: recording tool, routine test report Skilled personnel or personnel certified by ABB Adda Service at level 3	Repeat the commissioning test
Visual inspection of contacts and CB chamber condition	Every 20 years Tools needed: special tools ABB authorized Personnel only	No description need
Check of contact resistance of main circuit	Every 20 years Tools needed: micro ohmmeter, routine test report Skilled personnel or personnel certified by ABB Adda Service at level 2	IEC 694 (IEC 62271 – 1): Injection of test current > 100 A The measured resistance shall be within the allowed range defined by manufacturer.
Absence of corrosion or deterioration of components	Every 20 years No tools needed Unskilled personnel	Refer to manual specific Manual "SPARE PARTS"
Retighten screw joints related to anchor bolts and earthing connection	Every 20 years Tools needed: torque wrench, module layout Skilled personnel	Check the tighten of anchor bolts and earthing connection and retighten if necessary

Table 2

### 1.3. Revision

The revision of the PASS is carried out with the module out of service.  
It shall be done if one of the following conditions is reached:

- 10000 mechanical operations
- 40 years of service

**The general revision foresees at 40th year is carried out with the replacement of PASS module with one previously reconditioned in order to reduce the outage time. Complete module revision and replacement of worn part is made.**

#### Revision: module out of service



Note: all tools mentioned are not supplied by ABB, customer must provide them.  
Where ABB Personnel is indicated contact ABB Adda Service.

## 6

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NOTES

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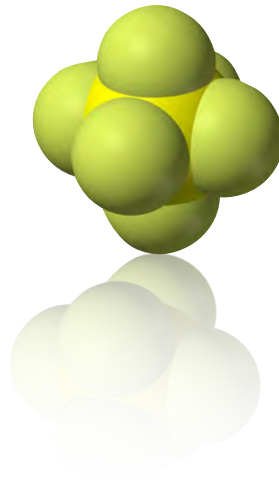
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# SF<sub>6</sub> Gas System

ORIGIN - FD217

Doc. 2GJA700294  
Rev. E 01/2013 [LM]  
Sulphur Hexafluoride Gas System  
SF<sub>6</sub> gas system

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# 1.Introduction

This document describes the general properties of sulphur hexafluoride (SF<sub>6</sub>), the safety instruction shall be taken during transportation, storage and the handling of SF<sub>6</sub>.

Sulphur hexafluoride gas (SF<sub>6</sub>) is used in PASS modules for insulation.

See the following Standards for technical details:

- IEC 60376 - Specification of technical grade sulphur hexafluoride (SF<sub>6</sub>) for use in electrical equipment.
- IEC 60480 - Guidelines for the checking and treatment of sulphur hexafluoride (SF<sub>6</sub>) taken from electrical equipment and specification for its re-use.
- IEC/TR 62271-303: High voltage switchgear and controlgear.

PLEASE NOTE THAT THE IEC /  
TR 62271-303 REGULATES ALL  
OPERATIONS EQUIPMENT CONTAINING  
GAS SF6: THEY MUST BE CARRIED  
OUT BY CERTIFIED PERSONNEL  
IN ACCORDANCE WITH THE  
PROCEDURES.

## 2. Sulphur Hexafluoride Gas (SF<sub>6</sub>)

### 2.1 Properties

The SF<sub>6</sub> is a synthetic gas composed by six atoms of fluorine and one central atom of sulphur. This chemical bond is known as one of the most stable existing atomic bonds.

SF<sub>6</sub> has the following characteristics:

High dielectric strength (about 3 times that of air )  
High thermal interruption capability (about 10 times that of air)  
High heating capability transfer (about twice the one of air)  
High arc quenching capability

Furthermore pure SF<sub>6</sub> is:

Tasteless  
Odourless  
Colourless  
Non-toxic  
Non-flammable  
Very stable  
Very inert.

Gas density 20 °C 100 kPa	6,07 kg/m <sup>3</sup>
Specific weight (20°C) [g/l]	6.07
Melting point [°C]	-63.7
Bolt point [°C]	-51
Thermal conductivity 25 ° C 100 kPa	0,013 W/(m.K)
Critical Temperature	45,58 °C
Critical Pressure	3,759 MPa
Critical Density	740 kg/m <sup>3</sup>
Water solubility 20 °C	6,31 cm <sup>3</sup> SF <sub>6</sub> /kg H <sub>2</sub> O
Water solubility [cm <sup>3</sup> ]	0.00054
Speed of Sound 0 °C 100 kPa	129,06 m/s
Refractive index	1,000783
Heat of formation	-1221,5801,0 kJ/mol
Entropy of reaction	-349,01 J/(mol.K)
Colour	Colourless
Odour	Odourless

### 2.2 Enviroment

SF<sub>6</sub> in the atmosphere contributes to global warming, thus the release of SF<sub>6</sub> into the atmosphere must be avoided whenever possible; every treatment of the gas must take place in a closed loop.

The commercial available gas service and filtering devices allow full recycling of SF<sub>6</sub>.  
In this way you will ensure that the contribution to the greenhouse effect remains negligible.



DO NOT RELEASE SF<sub>6</sub> IN THE  
ATMOSPHERE.  
SF<sub>6</sub> SHALL BE HANDLED IN A  
CLOSED LOOP WITH  
SUITABLE SF<sub>6</sub> SERVICE DEVICES AND  
BY ONLY  
TRAINED PERSONNEL.

## 2.3 Decomposition products

Commercial available SF<sub>6</sub> gas is non-hazardous and is therefore not subjected to the Ordinance for Hazardous Materials, including the technical regulations for hazardous materials (TRGS).

Chemically pure SF<sub>6</sub> gas cannot be detected with the sensory organs, whereas gaseous decomposition products give some warning signs even at low concentrations; such signs appear within seconds and before causing any hazardous impact:

Unpleasant pungent odour.  
Irritation of nostrils, mouth and eyes.

When these signs appear, the personnel shall leave the area immediately.

After an electrical discharge (switching operations, arcing), SF<sub>6</sub> gas will become more or less decomposed, depending on the amount of energy released.

As a result, gaseous and solid decomposition products are generated together with evaporated contact material, such as:

Metal fluorides, metal sulphides and metal oxides  
Sulphur fluorides, such as SF<sub>4</sub>  
Sulphur oxy-fluorides, such as SOF<sub>2</sub>, SO<sub>2</sub>F<sub>2</sub> and SOF<sub>4</sub>.

SF<sub>6</sub> decomposition products, generated from normal switching operations, will be absorbed by the built-in absorber (filter) and they doesn't present healthy risk.

If SF<sub>6</sub> decomposition products are present, the following protective devices shall be observed:

Disposable protective clothing  
Fully-protective breathing mask or breathing equipment (does not protect from a shortage of oxygen!), combined with close-fitting industrial goggles.  
Disposable protective gloves.

The protective equipment must be stored in an accessible location and in rooms away from the installation.

Density of SF<sub>6</sub> is approximately five times higher than the one of air. Due to the high density, SF<sub>6</sub> gas can collect in containers or low-lying rooms and replaces the oxygen. The maximum permissible concentration of SF<sub>6</sub> gas in the work room is 1000 ppm (by volume). There is a danger of asphyxiation if the ventilation is inadequate.



### **DECOMPOSITION PRODUCTS OF SF<sub>6</sub> CAN CAUSE IRRITATION OF SKIN, EYES AND MUCOUS MEMBRANES.**

Paying attention to the following safety information eliminates the potential risks associated with handling SF<sub>6</sub> and its decomposition products.



**IF THE CONCENTRATION OF SF<sub>6</sub> EXCEEDS THE 35% OF THE AIR VOLUME, IT LEADS TO OXYGEN LACK AND A POSSIBLE SUFFOCATION.**

**SUCH HIGH CONCENTRATIONS MAY OCCUR IN CLOSED, NON VENTILATED SF<sub>6</sub> GAS COMPARTMENTS, AND OCCASIONALLY AT LOW POINTS OF A BUILDING (E. G. IN BASEMENTS AND CABLE DUCTS).**

**WHEN WORKING WITH SF<sub>6</sub> GAS, ENSURE THAT THE WORKING ROOM IS KEPT CLEAN AND WELL VENTILATED (EXTRACTOR, BLOWER).**

**NO SMOKING, EATING OR DRINKING!**

## 3. Storage

The storage and transportation of SF<sub>6</sub> in containers or electrical equipments must be always in accordance with international laws.

### 3.1 Storage

Generally, the storage of SF<sub>6</sub> can be gaseous with a pressure less than 2 MPa, or liquid with pressure until 5 MPa.

### 3.2 Transportation

International rules, for transporting electrical power equipments filling with SF<sub>6</sub>, are available for:

- Road transportation (ADR)
- Rail transportation (RID)
- Ship transportation (IMDG code)
- Plane transportation (IATA – DGR)

The above mentioned rules are similar about the numeration, the classification, danger labelling, final classification and documents transportation.

### 3.3 Packing

SF<sub>6</sub> gas is delivered under pressure, in the liquid state at room temperature and inside steel vessels (bottles, spheres, cylinders, etc...). The gas mass is kept in a vessel with weights from 3 to 500 kg; the maximum filling density is 1.04 kg/dm<sup>3</sup>.

## 4. General Rules

Before starting any inspection / maintenance operations on electrical power equipments, it shall be verified the conditions of this one and write a report about it.

In addition to local security rules it must be observed the following prescriptions:

Disconnect the power electric equipments and isolate it  
Inhibit any reclosing operations  
Verify that the electrical equipments are out of work  
Connect the electrical equipments to the earth e to short circuit.

It is recommended showing a notice that prohibits the free flames, the smoke, use of thermal engines, the heating to more 200°C, the welding without special precautions and giving first aid instructions when handling the SF<sub>6</sub> in any locations.

### 4.1 Safety information for the personnel

When handling SF<sub>6</sub> and its decomposition products the following safety measures must be taken:

#### **Good ventilation**

Ventilate the room during maintenance works on the gas compartments (e. g. evacuating, filling, opening and cleaning). For maximum safety, it is advisable to have a second person present during all works.

#### **Avoid contact with decomposition products**

Avoid the contact, the swallow and the inhalation of decomposition products when the gas compartments are opened. Wear special protective clothing, such as plastic gloves, safety goggles, filtering mask and the personnel must properly dispose them after the completion of the works.

#### **Clean thorough of eyes and skin**

After contact with decomposition products immediately rinse with soap and plenty of water.

Thoroughly clean face, neck, arms and hands with soap and plenty of water before any interruptions and after completion of the works.

In case the eyes have been exposed to decomposition products, immediately rinse them with an aseptic solution (e. g. commercial NaCl solution). Consult a doctor in any case.

#### **Avoid shaking dust deposits**

Remove persistent solid decomposition products with a clean, dry cloth. Remove loose dust with a suitable vacuum cleaner with paper filters. The vacuum cleaner should work on the cyclone principle.

Used materials, single use suits, moisture filters of the gas compartments, filters of the vacuum cleaner, the masks and the service devices and all decomposition products and cleansers have to be disposed of in such a way, that decomposition products and the water soluble fluorides contained therein will not be released into the environment.

Do not open the filter bags. If the waste can not be disposed by a specialist, neutralize it in a soda lime solution (sodium hydroxide and calcium oxide).

#### **Wear protective clothing**

Wear a dust-tight overall, protective gloves and boots, cover the head and use a suitable respirator (separator, e. g. Auer 3S with combination filter 89 ABEK 2Hg/St. or, if a sufficient oxygen concentration has been measured, a filtering device), when entering in rooms that contain gas compartments which may hold toxic decomposition products.

#### **Do not eat, drink or smoke**

Do not drink, eat, smoke or store food in any room with open gas compartments, because it may contain decomposition products.

#### **Leave contaminated rooms**

If an unpleasant pungent odour (similar to hydrogen sulphide) indicates the presence of gaseous decomposition products, leave the room immediately.

Do not enter in the room before having thoroughly ventilated it, or without wearing a suitable respirator.

#### **Check oxygen concentration**

After faults, when potentially hazardous SF<sub>6</sub> concentrations are to be expected, do not enter in the switchgear room and all rooms at a lower level before thoroughly ventilating them and measuring the present oxygen contents (minimum 17 vol.%), or without wearing a suitable respirator.

Your local ABB Service will be happy to assist you with any problems related to reusing, cleaning or disposing of SF<sub>6</sub>.

## 5. Handling SF<sub>6</sub> during installation and commissioning

PASS consists of several individual gas compartments which are separated by means of gastight barrier insulators.

Each gas compartment is equipped with its own gas density relay and a gas fitting for working on. The gas density and the density relay fitting have a non-return valve to prevent unintentional gas losses.

If a gas compartment is evacuated after a long period of operation, the SF<sub>6</sub> has to be thoroughly filtered.

All gas compartments are delivered filled with SF<sub>6</sub> at reduced pressure of approximately 0.03 MPa relative.

Prior to filling it with SF<sub>6</sub>, a gas compartment has to be evacuated. The pressure in the gas compartment shall be measured with a sensitive pressure gauge.

### 5.1 Control of gas quality

The quality of the gas SF<sub>6</sub> can be tested using chemical and physical measurements stated by the IEC Recommendation. Generally, these measurements require sampling and laboratory instruments that guarantee a high accuracy in the measurement. However, it is possible to carry out some quality tests both on the gas available on the market and on the operating gas using simple instruments.

### 5.2 Control of dielectric strength

The dielectric strength is the basic characteristic of the SF<sub>6</sub>. By means the control of the dielectric strength, it's possible to identify the gas and to ensure its function of insulator. The dielectric strength can be easily measured with a cell equipped with a spark gap that is fed by a high voltage generator.

### 5.3 Air content

Only a considerable amount of air mixed with SF<sub>6</sub> will impair the dielectric strength of the SF<sub>6</sub> (see Figure 5). The small content of air allowed in the pure SF<sub>6</sub> has no effect on the dielectric strength. The treatments preceding the filling of SF<sub>6</sub>, when putting the equipment into service, leave a small residual amount of air that has no influence on the characteristics of the gas.

However, it is possible to check whether all the air has been removed before filling the enclosures with SF<sub>6</sub>, or whether, after a maintenance process in which the SF<sub>6</sub> has been recovered, a casual intake of air (for instance in pipes) has allowed a penetration of this one in the SF<sub>6</sub>.



**THE ENCLOSURE OF THE INDUCTIVE VOLTAGE  
TRANSFORMERS MUST NOT BE  
OPENED OR EVACUATED WITHOUT THE PRIOR  
CONSENT OF THE MANUFACTURER!**



Two methods are available:

#### IEC method:

Chromatography in the gaseous state  
Analyser that measures the paramagnetic susceptibility of oxygen.

#### Quick method:

Measurement of the dielectric strength of gas with a suitable test cell.

## 5.4 Filling pressure of SF<sub>6</sub>

The rated filling pressure (P<sub>n</sub>) of the SF<sub>6</sub> has been established at 20°C temperature value and at sea level atmospheric pressure.

It is necessary to adjust the pressure as a function of the actual temperature and/or adjust the pressure as a function of the altitude (P<sub>2</sub>) (see Figure 6).

The filling pressure at 20°C for each compartment is shown on the specific layout drawing of all projects.

For different temperatures the pressure shall be set accordance to Table "Filling Pressure as function of temperature".

## 5.5 How use the table of filling pressure

Read the rated filling pressure on the specific layout drawing, and choose the right pressure column (select from row 1)  
Choose the row correspondent to the actual measured temperature (select from column 1)  
The corresponding value on table is the correct filling pressure.

The gas temperature may differ from the ambient temperature, in particular in the following cases:

If the operational current passes through the equipment, the gas temperature will be higher than the ambient temperature. Use the enclosure temperature as reference temperature.  
During the filling operations, the gas cools down at the storage tank's outlet, as a consequence of its increase in volume, and is heated as it is compressed in the container to be filled. Therefore, the pressure must be adjusted a few hours after the operation, when the gas has reached the ambient temperature. This precaution can be omitted when a simple topping-up is involved.

The pressure shall be corrected by the increase of P<sub>2</sub> value in function of the altitude of the equipment; adjustment needed is approximately increased of 0.01 MPa rel. every 1000 m on the sea level.



**THE PASS IS SHIPPED WITH SF6 PRESSURE**

**0.02 - 0.03 MPa rel. at 20°C**

**EVERY TIME A PASS IS MOVED THE SF6 PRESSURE**

**SHALL BE AT 0.02 – 0.03 MPa rel. at 20°C**

**FOR WARNING AND LOCK OUT SF<sub>6</sub> THRESHOLD**

**PLEASE REFER TO THE SPECIFIC PROJECT**

**DOCUMENTATIONS.**

## 5.6 Preparation of gas compartments

All the module's gas compartments which must not be opened, they will be filled, after factory test, with SF<sub>6</sub> at 0.03 MPa relative.

Instead, all the module's gas compartments which must be opened during the installation, they will be closed with temporary covers during transportation and will be filled with N<sub>2</sub> at 0.03 MPa relative.

After module's assembling, empty the compartment by means vacuum pump until a pressure of 0.5 mm of Hg; maintain this pressure for 6 hours. (See Figures 8 and 9).

## 5.7 Filling with N<sub>2</sub>

Fill the gas compartment with dry nitrogen (humidity 3 ppm/V) at relative pressure 0.1 MPa (See Figure 8). Then wait 12 hours.

## 5.8 Vent N<sub>2</sub>

Vent N<sub>2</sub> until a pressure slightly higher than atmospheric pressure; then insert the molecular sieves. For the position, see the layout drawing.

Continue the emptying of compartment by means vacuum pump until a pressure of 0.5 mm of Hg and keep this pressure for 6 hours. Refilling with dry nitrogen (see 5.7).

## 5.9 Measure of humidity N<sub>2</sub>

Measure the humidity rate of dry nitrogen.

If the humidity rate is higher than 300 ppm/vol at 20°C, the result will be considered UNSATISFACTORY.

Thus, shall be repeated the following operations:

Empty by means vacuum pump until a pressure of 0.5 mm of Hg and keep this pressure for 6 hours.

Refilling with dry nitrogen at 0.1 MPa.

Stabilization for 12 hours.

Measure the humidity.

If the humidity rate is higher than 300 ppm/vol, it means there is anomaly and need a visual inspection.

If the humidity rate is less than 300 ppm/vol, the result will be considered SATISFACTORY.

## 5.10 Instructions for molecular sieves

The molecular sieves absorb humidity from SF<sub>6</sub> (see Figure 1).

It's therefore necessary to avoid leaving this material in contact with the air.

Molecular sieves left for 5 hours in a normal environment with humidity and temperature loose more than 50% of their absorption capability.

# FILLING PRESSURE AS FUNCTION OF TEMPERATURE

Figure 1

Temp	2.5	2.6	2.7	2.8	2.9	3	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5	4.6	4.7
-26	1.945	2.030	2.114	2.198	2.283	2.367	2.451	2.535	2.620	2.704	2.788	2.873	2.957	3.041	3.126	3.210	3.294	3.378	3.463	3.547	3.631	3.716	3.800
-24	1.969	2.054	2.139	2.224	2.309	2.394	2.479	2.564	2.649	2.734	2.819	2.904	2.989	3.074	3.159	3.244	3.329	3.414	3.499	3.584	3.669	3.754	3.839
-22	1.994	2.079	2.165	2.251	2.336	2.422	2.508	2.593	2.679	2.765	2.850	2.936	3.022	3.107	3.193	3.279	3.364	3.450	3.536	3.621	3.707	3.793	3.878
-20	2.018	2.104	2.190	2.277	2.363	2.449	2.536	2.622	2.708	2.795	2.881	2.968	3.054	3.140	3.227	3.313	3.399	3.486	3.572	3.658	3.745	3.831	3.917
-18	2.042	2.129	2.216	2.303	2.390	2.477	2.564	2.651	2.738	2.825	2.912	2.999	3.086	3.173	3.260	3.347	3.434	3.521	3.608	3.695	3.782	3.869	3.956
-16	2.066	2.154	2.241	2.329	2.417	2.504	2.592	2.680	2.768	2.855	2.943	3.031	3.118	3.206	3.294	3.382	3.469	3.557	3.645	3.732	3.820	3.908	3.996
-14	2.090	2.178	2.267	2.355	2.444	2.532	2.620	2.709	2.797	2.886	2.974	3.062	3.151	3.239	3.328	3.416	3.504	3.593	3.681	3.770	3.858	3.946	4.035
-12	2.114	2.203	2.292	2.381	2.470	2.560	2.649	2.738	2.827	2.916	3.005	3.094	3.183	3.272	3.361	3.450	3.539	3.628	3.718	3.807	3.896	3.985	4.074
-10	2.138	2.228	2.318	2.408	2.497	2.587	2.677	2.767	2.856	2.946	3.036	3.126	3.215	3.305	3.395	3.485	3.574	3.664	3.754	3.844	3.933	4.023	4.113
-8	2.162	2.253	2.343	2.434	2.524	2.615	2.705	2.795	2.886	2.976	3.067	3.157	3.248	3.338	3.429	3.519	3.609	3.700	3.790	3.881	3.971	4.062	4.152
-6	2.186	2.278	2.369	2.460	2.551	2.642	2.733	2.824	2.916	3.007	3.098	3.189	3.280	3.371	3.462	3.553	3.645	3.736	3.827	3.918	4.009	4.100	4.191
-4	2.211	2.302	2.394	2.486	2.578	2.670	2.761	2.853	2.945	3.037	3.129	3.221	3.312	3.404	3.496	3.588	3.680	3.771	3.863	3.955	4.047	4.139	4.230
-2	2.235	2.327	2.420	2.512	2.605	2.697	2.790	2.882	2.975	3.067	3.160	3.252	3.345	3.437	3.530	3.622	3.715	3.807	3.900	3.992	4.085	4.177	4.270
0	2.259	2.352	2.445	2.538	2.632	2.725	2.818	2.911	3.004	3.097	3.191	3.284	3.377	3.470	3.563	3.656	3.750	3.843	3.936	4.029	4.122	4.215	4.309
2	2.283	2.377	2.471	2.565	2.658	2.752	2.846	2.940	3.034	3.128	3.222	3.315	3.409	3.503	3.597	3.691	3.785	3.879	3.972	4.066	4.160	4.254	4.348
4	2.307	2.402	2.496	2.591	2.685	2.780	2.874	2.969	3.063	3.158	3.252	3.347	3.442	3.536	3.637	3.725	3.820	3.914	4.009	4.103	4.198	4.292	4.387
6	2.331	2.426	2.522	2.617	2.712	2.807	2.903	2.998	3.093	3.188	3.283	3.379	3.474	3.569	3.664	3.760	3.855	3.950	4.045	4.140	4.236	4.331	4.426
8	2.355	2.451	2.547	2.643	2.739	2.835	2.931	3.027	3.123	3.218	3.314	3.410	3.506	3.602	3.698	3.794	3.890	3.986	4.082	4.177	4.273	4.369	4.465
10	2.379	2.476	2.573	2.669	2.766	2.862	2.959	3.056	3.152	3.249	3.345	3.442	3.538	3.635	3.732	3.828	3.925	4.021	4.118	4.215	4.311	4.408	4.504
12	2.404	2.501	2.598	2.695	2.793	2.890	2.987	3.084	3.182	3.279	3.376	3.474	3.571	3.668	3.765	3.863	3.960	4.057	4.154	4.252	4.349	4.446	4.543
14	2.428	2.526	2.624	2.722	2.819	2.917	3.015	3.113	3.211	3.309	3.407	3.505	3.603	3.701	3.799	3.897	3.995	4.093	4.191	4.289	4.387	4.485	4.583
16	2.452	2.550	2.649	2.748	2.846	2.945	3.044	3.142	3.241	3.339	3.438	3.537	3.635	3.734	3.833	3.931	4.030	4.129	4.227	4.326	4.424	4.523	4.622
18	2.476	2.575	2.675	2.774	2.873	2.972	3.072	3.171	3.270	3.370	3.469	3.568	3.668	3.767	3.866	3.966	4.065	4.164	4.264	4.363	4.462	4.562	4.661
20	2.500	2.600	2.700	2.800	2.900	3.000	3.100	3.200	3.300	3.400	3.500	3.600	3.700	3.800	3.900	4.000	4.100	4.200	4.300	4.400	4.500	4.600	4.700
22	2.524	2.625	2.725	2.826	2.927	3.028	3.128	3.229	3.330	3.430	3.531	3.632	3.732	3.833	3.934	4.034	4.135	4.236	4.336	4.437	4.538	4.638	4.739
24	2.548	2.650	2.751	2.852	2.954	3.055	3.156	3.258	3.359	3.461	3.562	3.663	3.765	3.866	3.967	4.069	4.170	4.271	4.373	4.474	4.576	4.677	4.778
26	2.572	2.674	2.776	2.878	2.981	3.083	3.185	3.287	3.389	3.491	3.593	3.695	3.797	3.899	4.001	4.103	4.205	4.307	4.409	4.511	4.613	4.715	4.817
28	2.596	2.699	2.802	2.905	3.007	3.110	3.213	3.316	3.418	3.521	3.624	3.726	3.829	3.932	4.035	4.137	4.240	4.343	4.446	4.548	4.651	4.754	4.857
30	2.621	2.724	2.827	2.931	3.034	3.138	3.241	3.344	3.448	3.551	3.655	3.758	3.862	3.965	4.068	4.172	4.275	4.379	4.482	4.585	4.689	4.792	4.896
32	2.645	2.749	2.853	2.957	3.061	3.165	3.269	3.373	3.477	3.582	3.686	3.790	3.894	3.998	4.102	4.206	4.310	4.414	4.518	4.623	4.727	4.831	4.935
34	2.669	2.774	2.878	2.983	3.088	3.193	3.297	3.402	3.507	3.612	3.717	3.821	3.926	4.031	4.136	4.240	4.345	4.450	4.555	4.660	4.764	4.869	4.974
36	2.693	2.798	2.904	3.009	3.115	3.220	3.326	3.431	3.537	3.642	3.748	3.853	3.958	4.064	4.169	4.275	4.380	4.486	4.591	4.697	4.802	4.908	5.013
38	2.717	2.823	2.929	3.035	3.142	3.248	3.354	3.460	3.566	3.672	3.778	3.885	3.991	4.097	4.203	4.309	4.415	4.521	4.628	4.734	4.840	4.946	5.052
40	2.741	2.848	2.955	3.062	3.168	3.275	3.382	3.489	3.596	3.703	3.809	3.916	4.023	4.130	4.237	4.344	4.450	4.557	4.664	4.771	4.878	4.985	5.091

Filling relative Bar (with a constant density at 20 ° C and 760 mmHg)

To convert the values in MPa, multiply by 0.1

# FILLING PRESSURE AS FUNCTION OF TEMPERATURE

Figure 1

Temp.	4,8	4,9	5	5,1	5,2	5,3	5,4	5,5	5,6	5,7	5,8	5,9	6	6,1	6,2	6,3	6,4	6,5	6,6	6,7	6,8	6,9	7
-26	3,884	3,969	4,053	4,137	4,221	4,306	4,390	4,474	4,559	4,643	4,727	4,812	4,896	4,980	5,064	5,148	5,232	5,316	5,400	5,484	5,568	5,652	5,736
-24	3,924	4,009	4,094	4,179	4,264	4,349	4,434	4,519	4,604	4,689	4,774	4,859	4,944	5,029	5,114	5,199	5,284	5,369	5,454	5,539	5,624	5,709	5,794
-22	3,964	4,050	4,135	4,221	4,307	4,392	4,478	4,564	4,649	4,735	4,821	4,906	4,992	5,078	5,164	5,250	5,336	5,422	5,508	5,594	5,680	5,766	5,852
-20	4,004	4,090	4,176	4,263	4,349	4,435	4,522	4,608	4,694	4,781	4,867	4,954	5,040	5,126	5,212	5,298	5,384	5,470	5,556	5,642	5,728	5,814	5,900
-18	4,044	4,131	4,218	4,305	4,392	4,479	4,566	4,653	4,740	4,827	4,914	5,001	5,088	5,175	5,262	5,349	5,436	5,523	5,610	5,697	5,784	5,871	5,958
-16	4,083	4,171	4,259	4,346	4,434	4,522	4,610	4,697	4,785	4,873	4,960	5,048	5,136	5,224	5,312	5,400	5,488	5,576	5,664	5,752	5,840	5,928	6,016
-14	4,123	4,212	4,300	4,388	4,477	4,565	4,654	4,742	4,830	4,919	5,007	5,095	5,184	5,273	5,362	5,451	5,540	5,629	5,718	5,807	5,896	5,985	6,074
-12	4,163	4,252	4,341	4,430	4,519	4,608	4,697	4,786	4,876	4,965	5,054	5,143	5,232	5,321	5,410	5,499	5,588	5,677	5,766	5,855	5,944	6,033	6,122
-10	4,203	4,293	4,382	4,472	4,562	4,652	4,741	4,831	4,921	5,011	5,100	5,190	5,280	5,370	5,460	5,550	5,640	5,730	5,820	5,910	6,000	6,090	6,180
-8	4,243	4,333	4,423	4,514	4,604	4,695	4,785	4,876	4,966	5,057	5,147	5,237	5,328	5,419	5,510	5,601	5,692	5,783	5,874	5,965	6,056	6,147	6,238
-6	4,282	4,374	4,465	4,556	4,647	4,738	4,829	4,920	5,011	5,103	5,194	5,285	5,376	5,467	5,558	5,649	5,740	5,831	5,922	6,013	6,104	6,195	6,286
-4	4,322	4,414	4,506	4,598	4,689	4,781	4,873	4,965	5,057	5,148	5,240	5,332	5,424	5,516	5,608	5,700	5,792	5,884	5,976	6,068	6,160	6,252	6,344
-2	4,362	4,455	4,547	4,640	4,732	4,824	4,917	5,009	5,102	5,194	5,287	5,379	5,472	5,565	5,658	5,751	5,844	5,937	6,030	6,123	6,216	6,309	6,402
0	4,402	4,495	4,588	4,681	4,775	4,868	4,961	5,054	5,147	5,240	5,334	5,427	5,520	5,613	5,706	5,799	5,892	5,985	6,078	6,171	6,264	6,357	6,450
2	4,442	4,536	4,629	4,723	4,817	4,911	5,005	5,099	5,193	5,286	5,380	5,474	5,568	5,662	5,756	5,850	5,944	6,038	6,132	6,226	6,320	6,414	6,508
4	4,481	4,576	4,671	4,765	4,860	4,954	5,049	5,143	5,238	5,332	5,427	5,521	5,616	5,711	5,806	5,901	5,996	6,091	6,186	6,281	6,376	6,471	6,566
6	4,521	4,617	4,712	4,807	4,902	4,997	5,093	5,188	5,283	5,378	5,474	5,569	5,664	5,759	5,854	5,949	6,044	6,139	6,234	6,329	6,424	6,519	6,614
8	4,561	4,657	4,753	4,849	4,945	5,041	5,137	5,232	5,328	5,424	5,520	5,616	5,712	5,808	5,904	6,000	6,096	6,192	6,288	6,384	6,480	6,576	6,672
10	4,601	4,698	4,794	4,891	4,987	5,084	5,180	5,277	5,374	5,470	5,567	5,663	5,760	5,857	5,954	6,051	6,148	6,245	6,342	6,439	6,536	6,633	6,730
12	4,641	4,738	4,835	4,933	5,030	5,127	5,224	5,322	5,419	5,516	5,613	5,711	5,808	5,905	6,002	6,099	6,196	6,293	6,390	6,487	6,584	6,681	6,778
14	4,681	4,779	4,876	4,974	5,072	5,170	5,268	5,366	5,464	5,562	5,660	5,758	5,856	5,954	6,052	6,150	6,248	6,346	6,444	6,542	6,640	6,738	6,836
16	4,720	4,819	4,918	5,016	5,115	5,214	5,312	5,411	5,509	5,608	5,707	5,805	5,904	6,003	6,102	6,201	6,300	6,399	6,498	6,597	6,696	6,795	6,894
18	4,760	4,860	4,959	5,058	5,157	5,257	5,356	5,455	5,555	5,654	5,753	5,853	5,952	6,051	6,150	6,249	6,348	6,447	6,546	6,645	6,744	6,843	6,942
20	4,800	4,900	5,000	5,100	5,200	5,300	5,400	5,500	5,600	5,700	5,800	5,900	6,000	6,100	6,200	6,300	6,400	6,500	6,600	6,700	6,800	6,900	7,000
22	4,840	4,940	5,041	5,142	5,243	5,343	5,444	5,545	5,645	5,746	5,847	5,947	6,048	6,149	6,250	6,351	6,452	6,553	6,654	6,755	6,856	6,957	7,058
24	4,880	4,981	5,082	5,184	5,285	5,386	5,488	5,589	5,691	5,792	5,893	5,995	6,096	6,197	6,298	6,399	6,500	6,601	6,702	6,803	6,904	7,005	7,106
26	4,919	5,021	5,124	5,226	5,328	5,430	5,532	5,634	5,736	5,838	5,940	6,042	6,144	6,246	6,348	6,450	6,552	6,654	6,756	6,858	6,960	7,062	7,164
28	4,959	5,062	5,165	5,267	5,370	5,473	5,576	5,678	5,781	5,884	5,987	6,089	6,192	6,295	6,398	6,501	6,604	6,707	6,810	6,913	7,016	7,119	7,222
30	4,999	5,102	5,206	5,309	5,413	5,516	5,620	5,723	5,826	5,930	6,033	6,137	6,240	6,343	6,446	6,549	6,652	6,755	6,858	6,961	7,064	7,167	7,270
32	5,039	5,143	5,247	5,351	5,455	5,559	5,663	5,768	5,872	5,976	6,080	6,184	6,288	6,392	6,496	6,600	6,704	6,808	6,912	7,016	7,120	7,224	7,328
34	5,079	5,183	5,288	5,393	5,498	5,603	5,707	5,812	5,917	6,022	6,126	6,231	6,336	6,441	6,546	6,651	6,756	6,861	6,966	7,071	7,176	7,281	7,386
36	5,119	5,224	5,329	5,435	5,540	5,646	5,751	5,857	5,962	6,068	6,173	6,279	6,384	6,489	6,594	6,699	6,804	6,909	7,014	7,119	7,224	7,329	7,434
38	5,158	5,264	5,371	5,477	5,583	5,689	5,795	5,901	6,007	6,114	6,220	6,326	6,432	6,538	6,644	6,750	6,856	6,962	7,068	7,174	7,280	7,386	7,492
40	5,198	5,305	5,412	5,519	5,625	5,732	5,839	5,946	6,053	6,160	6,266	6,373	6,480	6,587	6,694	6,801	6,908	7,015	7,122	7,229	7,336	7,443	7,550

Filling relative Bar (with a constant density at 20 °C and 760 mmHg)

To convert the values in MPa, multiply by 0.1

## 5.11 Filling the equipment with SF<sub>6</sub>

Fill with gas until the correct pressure; it is reached considering the temperature and the atmospheric pressure conditions at the time of filling.

The filling must be carried out in all the compartments shipped with SF<sub>6</sub> (see Figure 2 in the next page).

- Unscrew the cap (1) from the valve (2)
- Insert the pressure gauge (3) in the valve and secure it in position with the nut (4)
- Read the pressure value
- Unscrew the cap (5) from the valve (6)
- Completely unscrew the regulator knob (7)
- Open the cylinder valve (8) on the bottle (9) and read the pressure inside the bottle on the High-Pressure gauge (10)
- Tighten the regulator knob (7) until the low pressure gauge (11) indicates the rated pressure required for filling the compartment
- Wash the hose (12) of the topping up device, opening the hose valve (13) of the panel slightly and press the non return valve (14) on the valve (15) for few seconds, so that the gas may flow out, then release the non return valve so that pressure is applied to the hose (12)
- Insert the hose coupling (15) in the valve (6) and tighten it in position using the nut (16)
- Fill with gas, checking the pressure value on the pressure gauge (3), until the pressure returns to the specified rated value.

At the end of the filling operation:

Close the cylinder valve (8) on the bottle (9)

Remove the hose (12) from the valve (6) and place the cap (5), on the latter

Remove the pressure gauge (3) from the valve (2) and close with the cap (1) on the latter

Check the seal of the valves (2 and 6) with the leak detector.

The filling devices (see from pos. 7 to pos. 17 in Figure 2) and the pressure gauge (pos. 3) is not included in the supply.

Wait for one week after filling for the stabilization.

The refilling procedure is a repetition of the above steps.

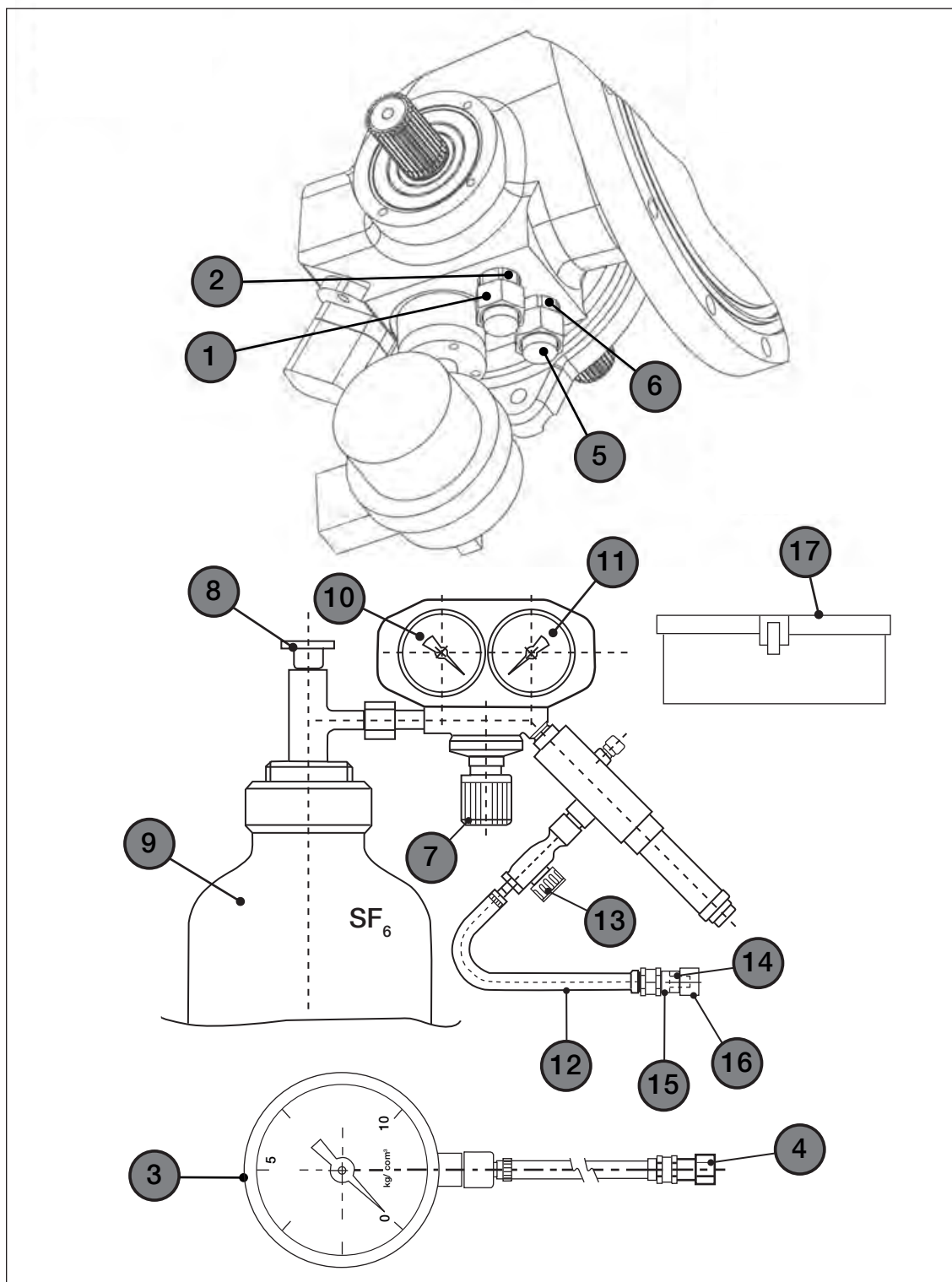


figure. 2

Legend:

- |                            |                      |
|----------------------------|----------------------|
| 1. cap                     | 9. bottle            |
| 2. valve                   | 10. H.P. gauge       |
| 3. pressure gauge          | 11. L.P. gauge       |
| 4. nut                     | 12. hose             |
| 5. cap                     | 13. hose valve       |
| 6. filling device DILO DN8 | 14. non-return valve |
| 7. regulation valve        | 15. hose coupling    |
| 8. cylinder valve          | 16. nut              |
|                            | 17. instrument case  |



**COMPARTMENT ONLY,  
NOT FOR VT FILLING**

## 5.12 Gas moisture content

Measure the humidity rate according to the instructions of the humidity analyzer device.

If the humidity rate is higher than 500 ppm/vol for the station or 250 ppm/vol for CB, the result will be considered UNSATISFACTORY.

In this case, recover the SF<sub>6</sub> and repeat the treatment with dry nitrogen (see Filling with dry nitrogen paragraph).

Filling with dry nitrogen (humidity 3 ppm/vol) at relative pressure 0.1 MPa.

If the humidity rate proves lower than 500 ppm/vol for the station and 250 ppm/vol for the circuit breaker, the result will be considered SATISFACTORY.

## 6. Maintenance

### 6.1 Control of gas pressure

The periodical control of gas pressure must be carried out according specific instruction of the equipment.

### 6.2 Control of humidity contained in gas

The periodical check of gas humidity must be carried out (see Preventive maintenance manual).

## 7. Dismantling of electrical equipment contained SF<sub>6</sub> at the end-of-life

The dismantling of electrical equipment filled with SF<sub>6</sub>, shall be in accordance with local laws.

The treatment and the dismantling of gas compartments shall be made considering the respect for the environment and the safety for the personnel.

For more information, see the IEC/TR 62271-303.

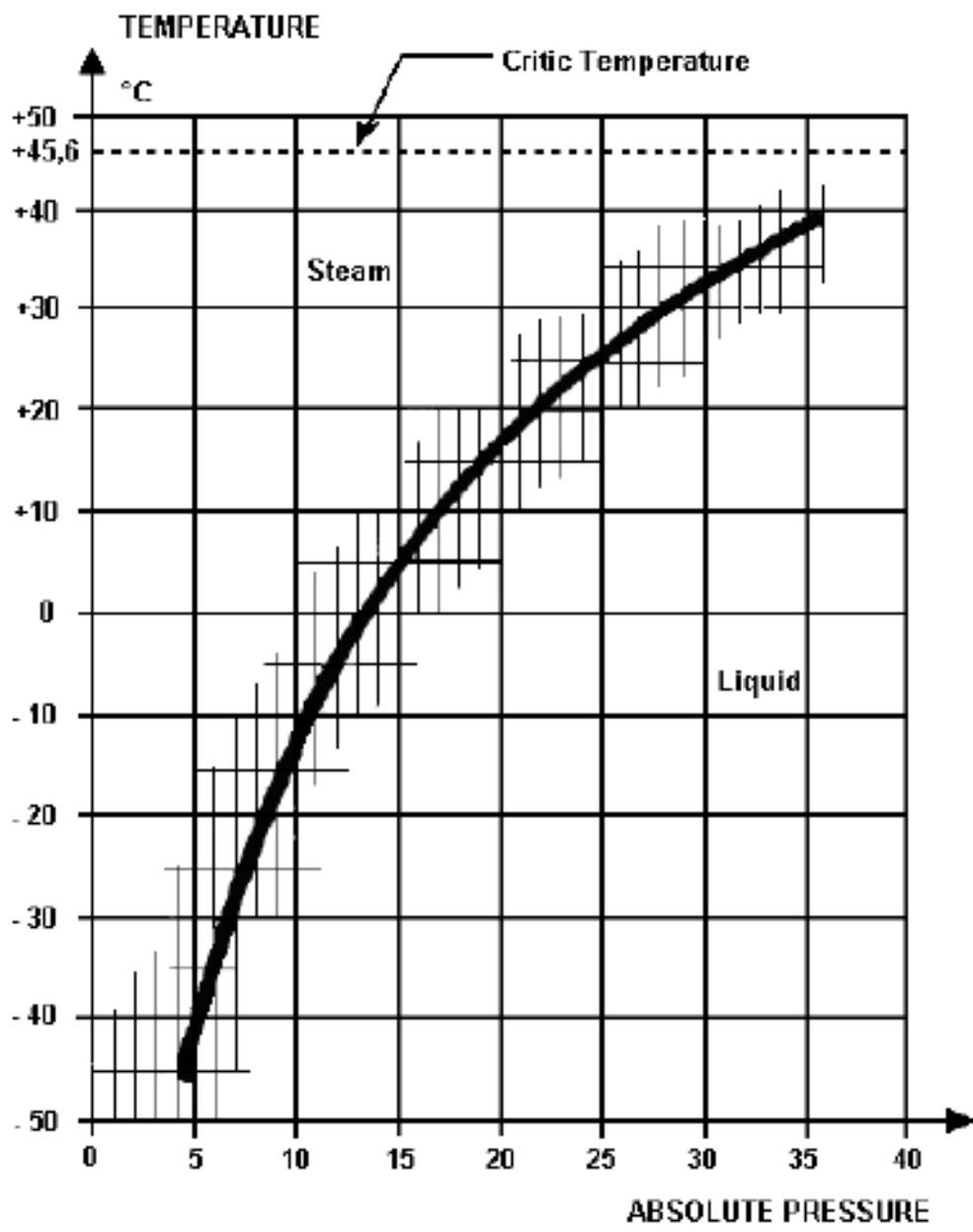
## 8. Operation



**DO NOT OPERATE THE CIRCUIT BREAKER AT LOW  
PRESSURE OF 0.02-0.03 MPa rel. at 20°C.**

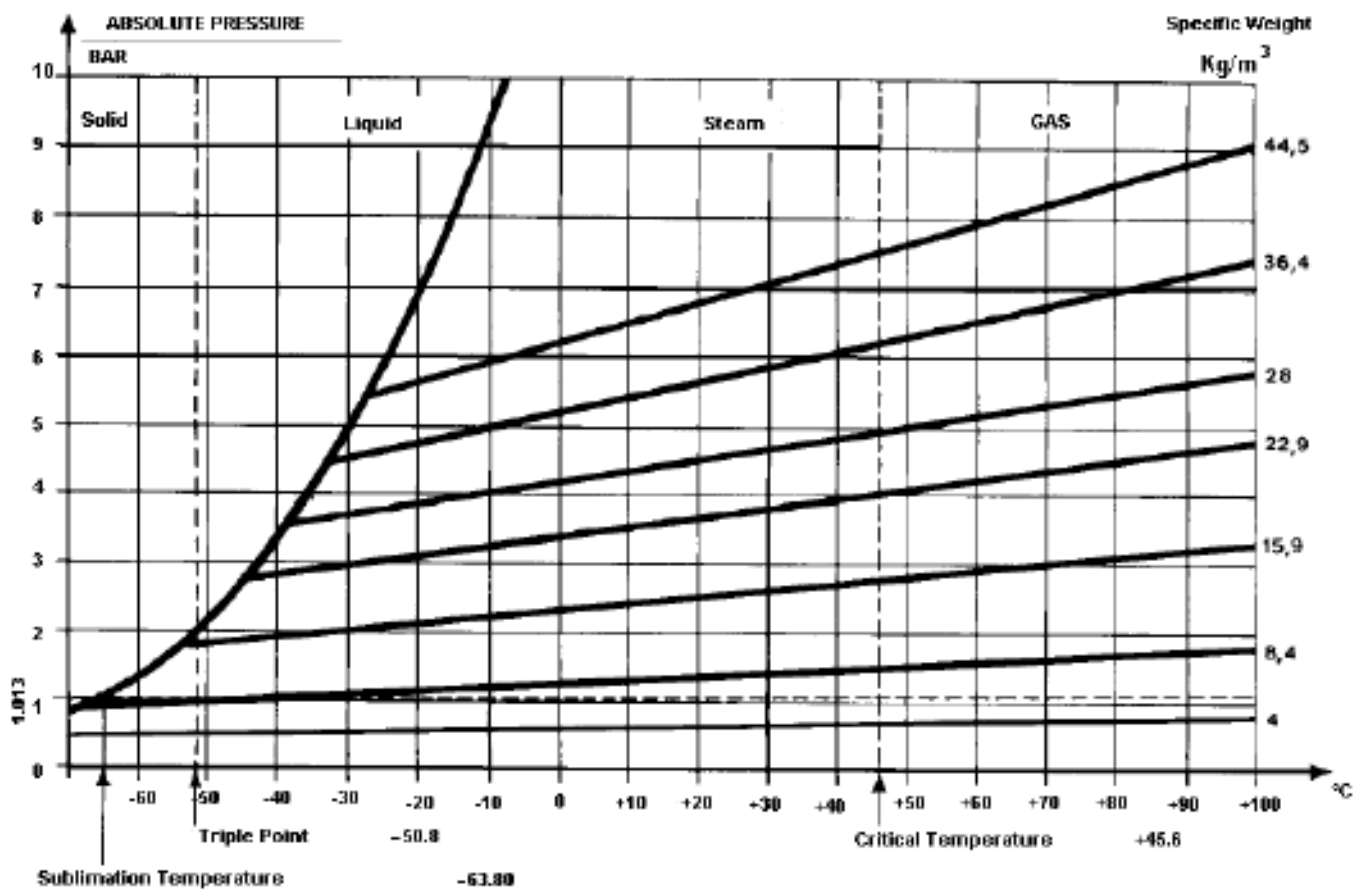
**OPERATE WHEN THE PRESSURE IS IN AC-  
CORDANCE WITH THE LAYOUT DRAWING.**



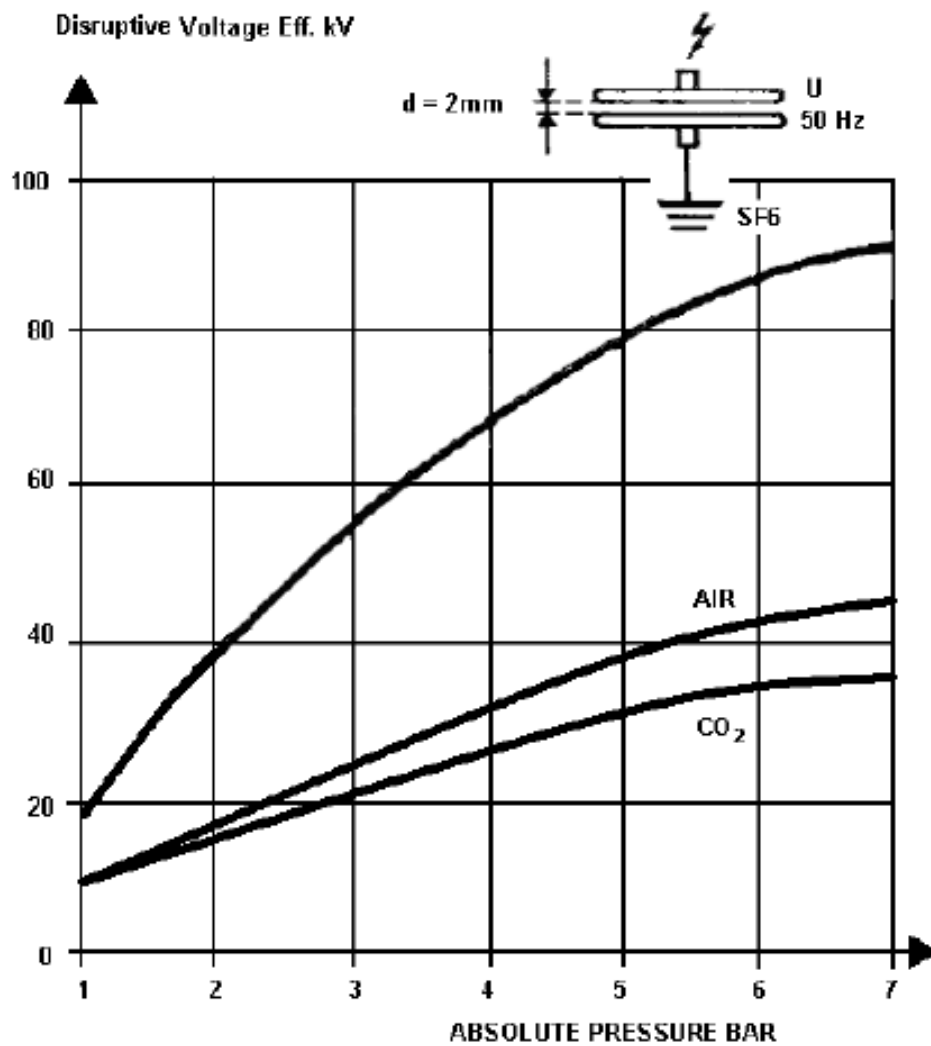


Pressure for full Gas SF6

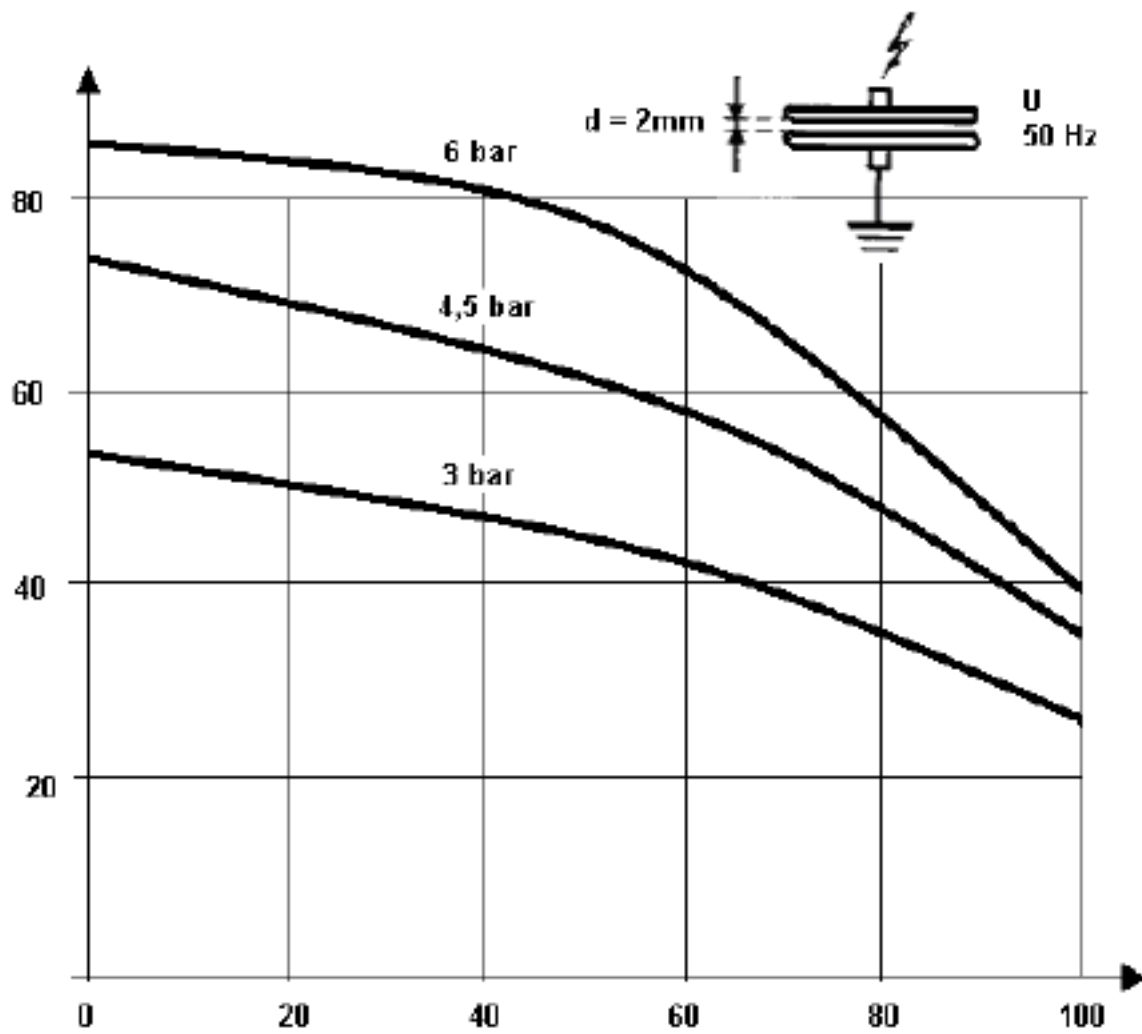


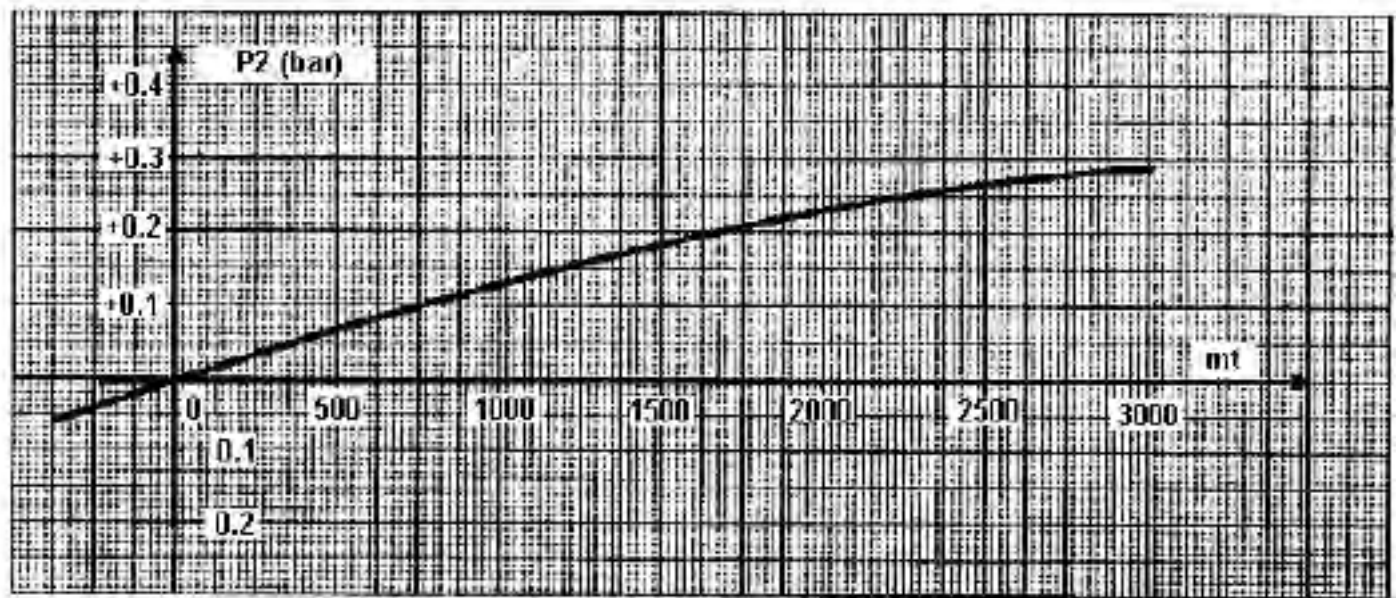


Pressure-Temperature diagram with constant specific weight

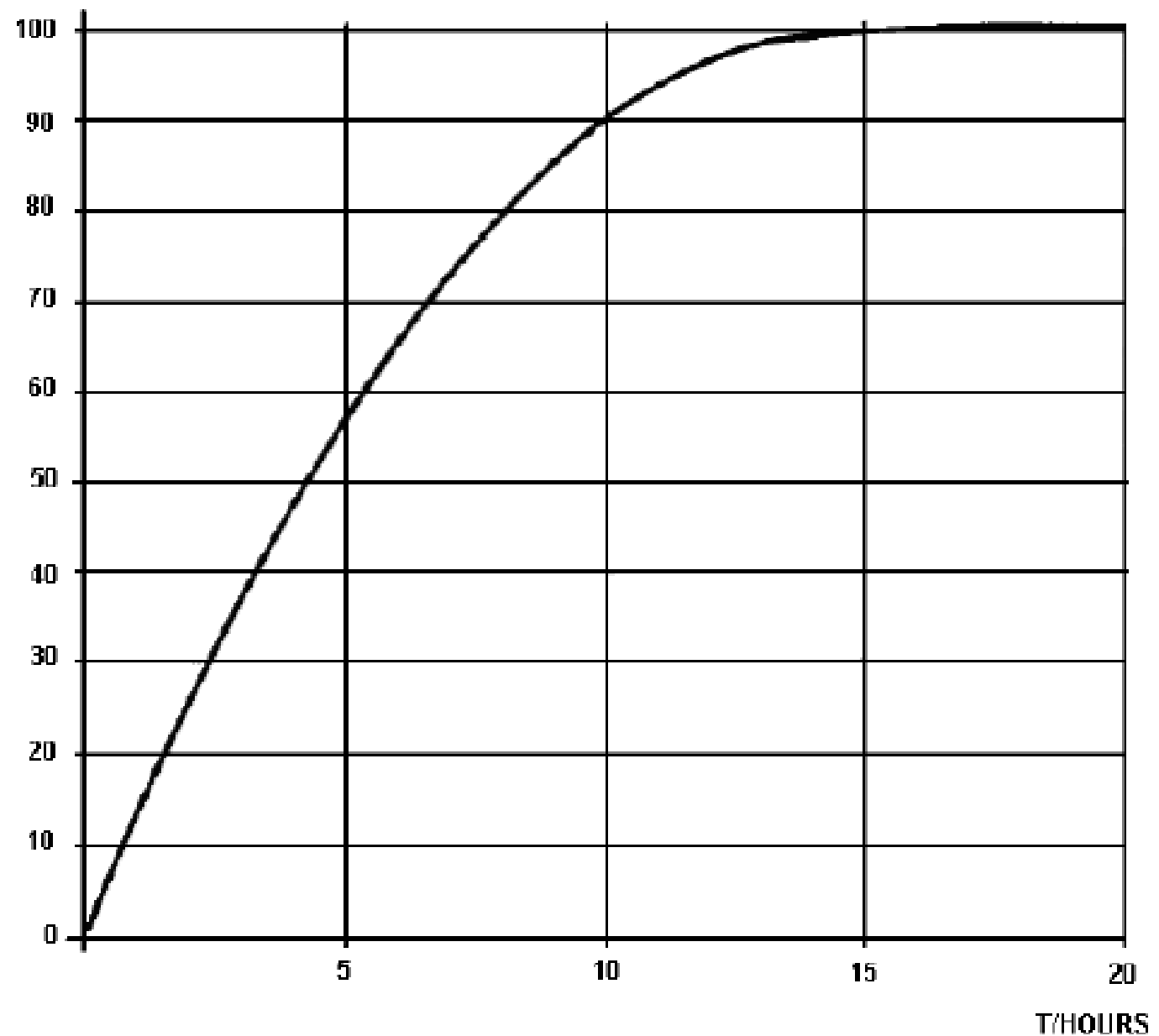


Disruptive voltage (kV) SF6, air and carbon dioxide as a function of the pressure

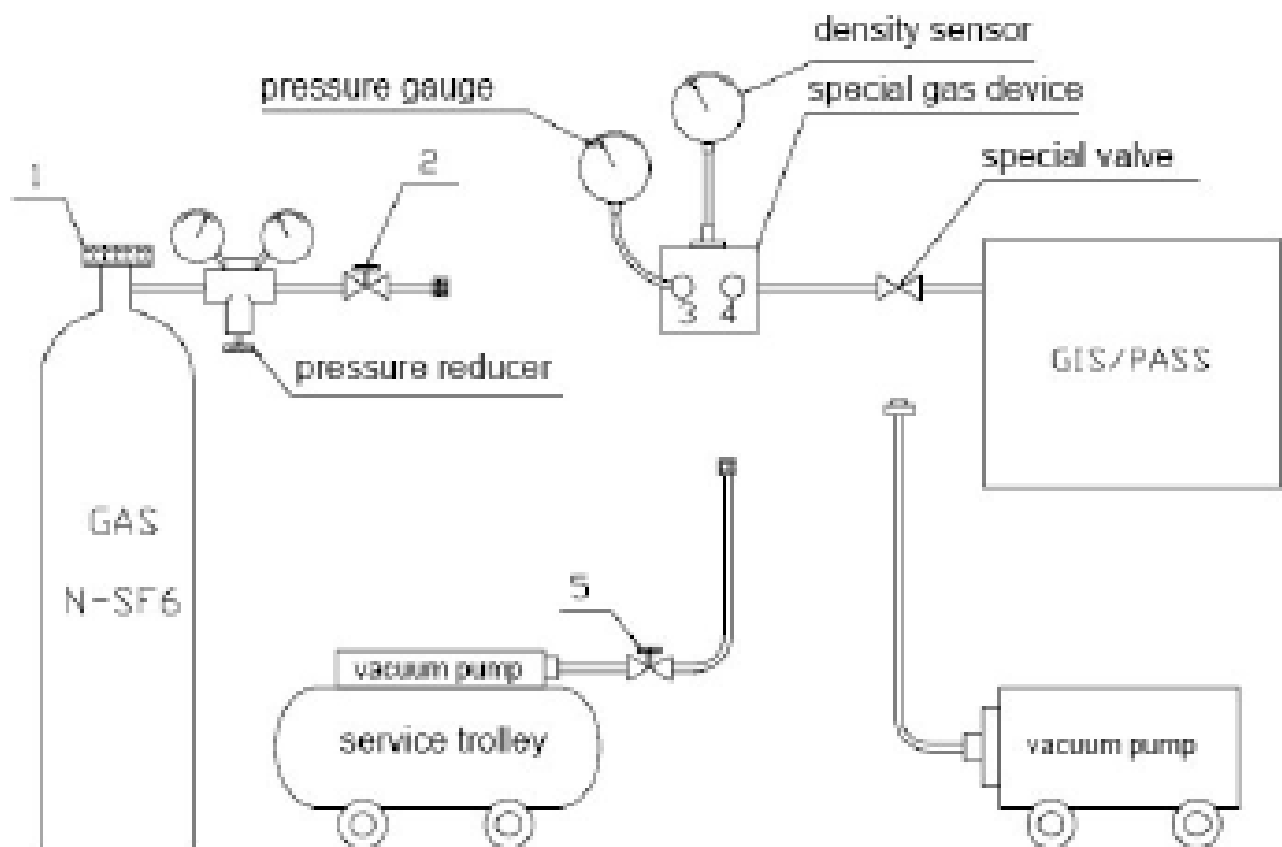




### % ABSORPTION CAPACITY OF MOLECULAR BAGS







## NOTES

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Thank You for your collaboration.

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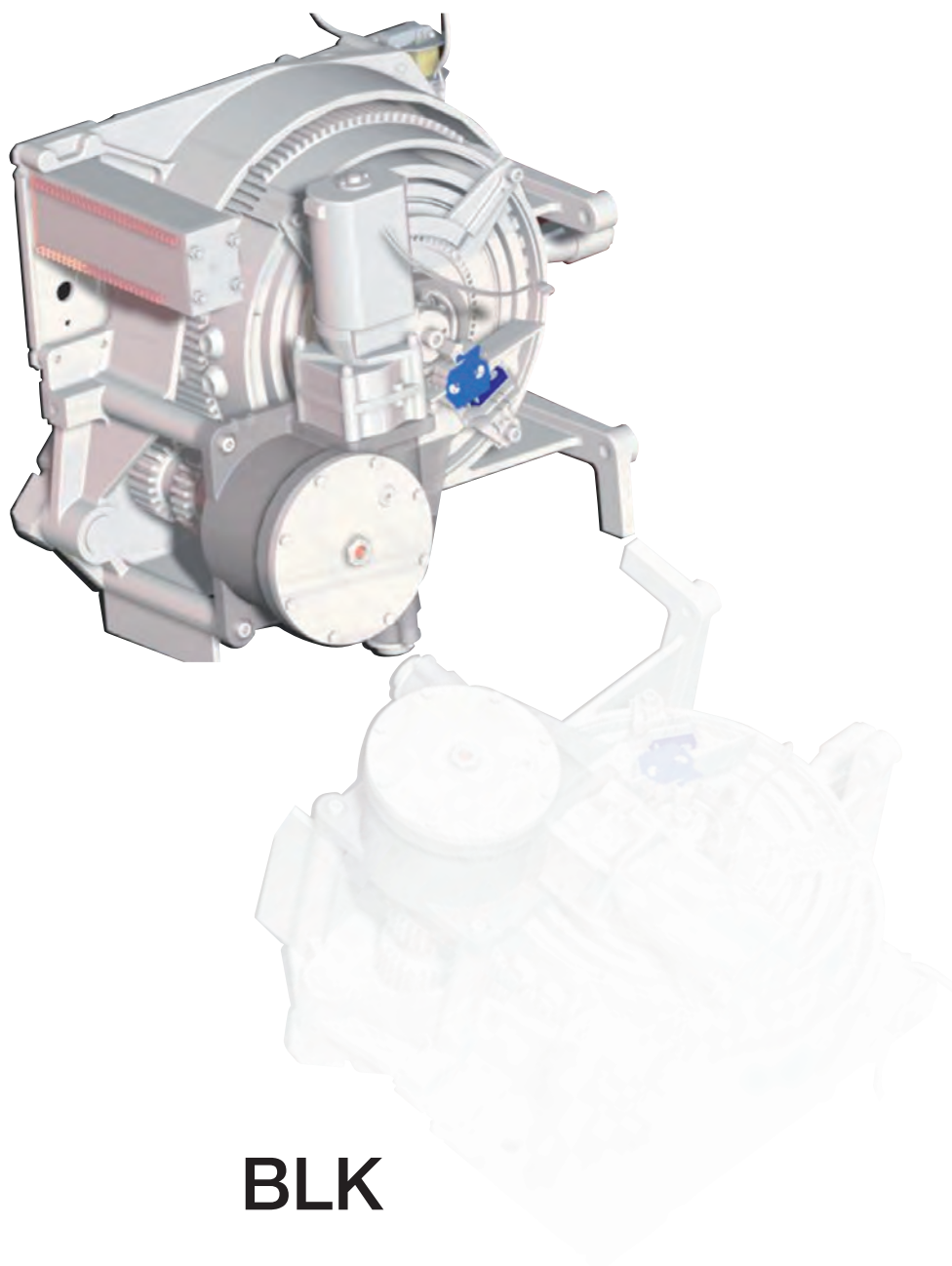
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**BLK**

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# 1. General Information

## 1.3 BLK 222

### 1.1 Components

The spring operating mechanisms type BLK 82 and BLK 222 are designed with a minimum number of components.

The power pack is characterized by the following robust main components and features:

- all power components are carried on the same main shaft carried by the structure;
- the closing spiral spring directly drives the lever of the circuit breaker without any intermediate cam disc or shaft;
- the spiral spring is charged by a standard universal motor;
- the trip and closing latches are identical, fast acting and vibration proof;
- a damping device is included to retard the motion of the contact system in the end position;
- a closed oil-filled worm drive for a minimum of maintenance.

**The auxiliary equipment** is characterized by the following main components:

- most electrical wiring is taken to terminal blocks;
- good accessibility through large housing and hinge-equipped control panel.

**The housing** of the spring operating mechanism is characterized by the following features:

- front and back doors equipped with stops and door lockable by pad locks;
- insulated doors and walls for low energy consumption and low noise level.

### 1.2 BLK 82

**The auxiliary equipment** is characterized by the following main components:

- the breaker is equipped with a central cubicle and cable connections with multi-contact for fast connection with the operating mechanism.

**The housing** of the spring operating mechanism is characterized by the following features:

- insulated walls for low energy consumptions and low noise level;
- cabinet lockable by pad lock.

### 1.4 BLK (Optional Equipment)

- Manual trip push-button inside or outside cubicle;
- trip circuit supervision;
- internal light with door switch;
- provision for "Castell" or "Fortress" interlock;
- extra closing coil;
- lockable operating switches;
- protective cover for terminal blocks.



During assembling and transport, the closing spring of control device must be discharged. Discharged condition is shown by the color signs from the window (Figure A.1). Do not operate the control device before it has been coupled and adjusted to the circuit breaker and the circuit breaker has been filled with gas, to full service pressure.

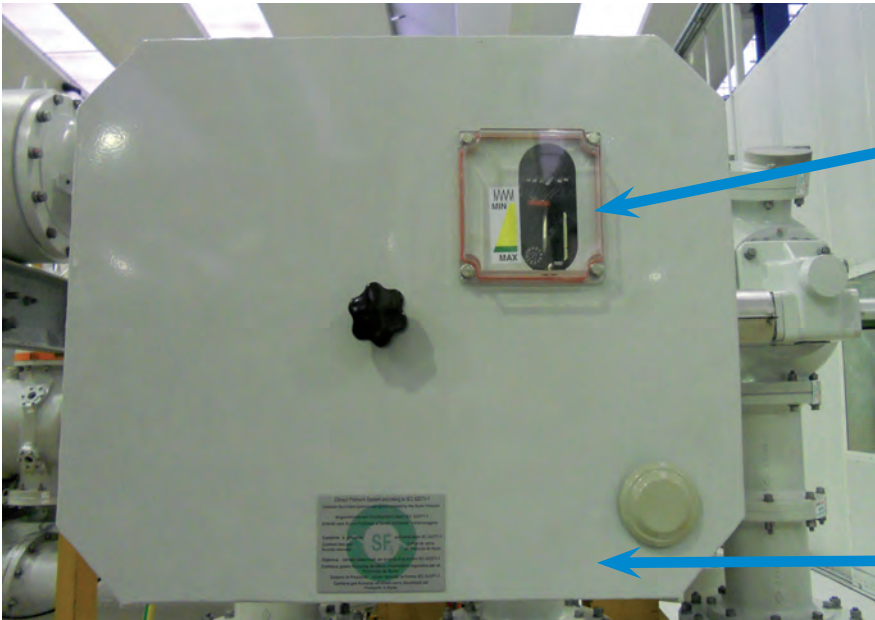
### BLK222 COVER



**Fig. A.1**  
Back cover of BLK 222 for manual charge of closing spring

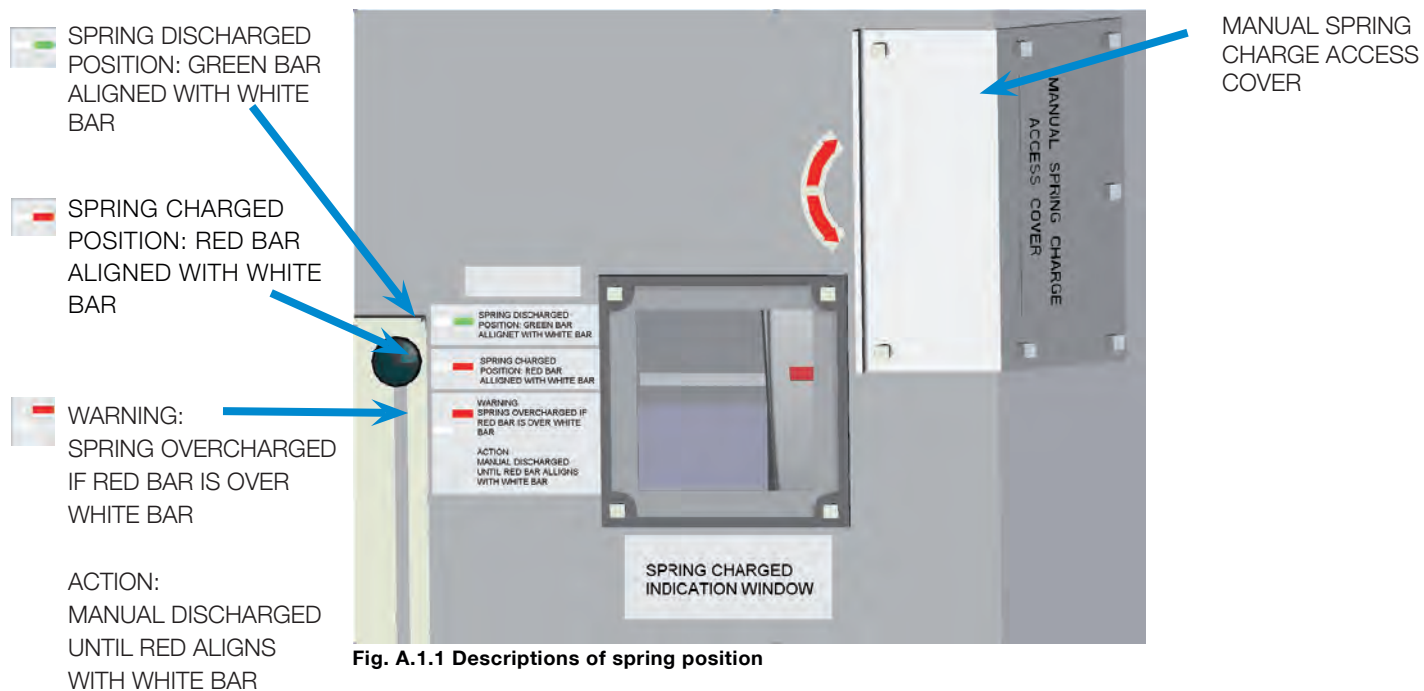
**Fig. A.1**  
Window under cover of BLK 222

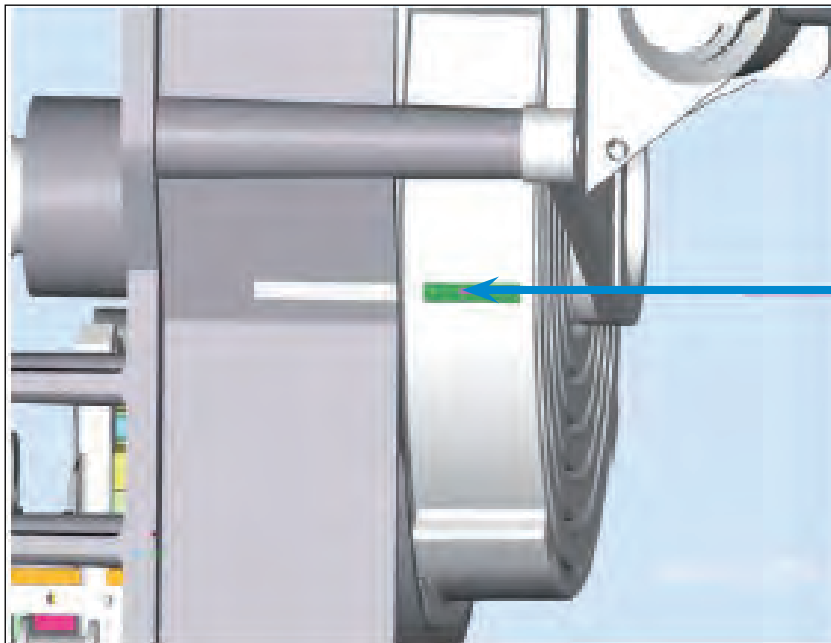
### BLK82 COVER



**Fig. A.2** Window of the state of charge of the closing spring (BLK 82).

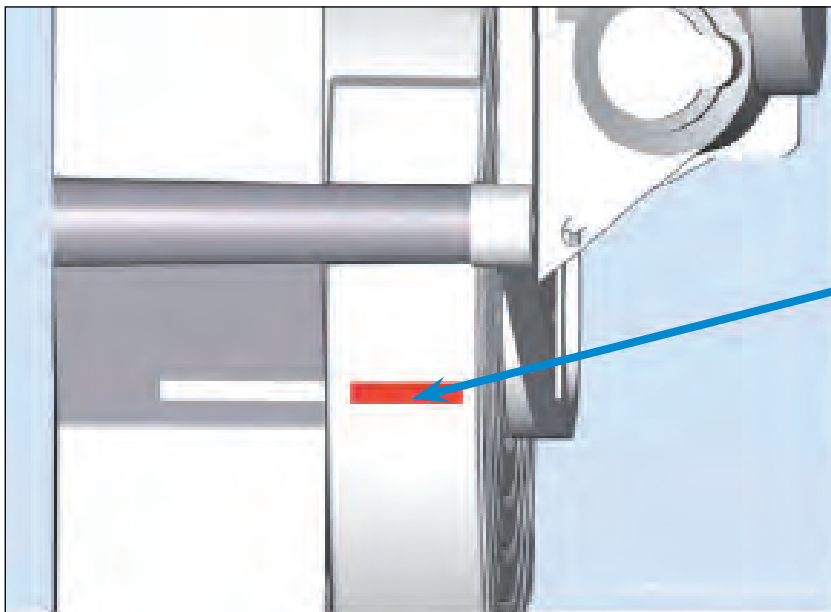
**Fig. A.2** Small removable lower cover for manual charge of closing spring (BLK 82).





**Fig. B.1**  
Green sign in line with  
white sign: SPRING  
DISCHARGED

**Fig. B1 Spring Discharged**



**Fig. B.2**  
Red Sign in line  
with white sign:  
SPRING CHARGED

**Fig. B2**



# 2. Main components and equipment

## 2.1 Operating Device Cubicle (Fig. C)

Fig. C Legend:

1. Cover
2. Locking handle
3. Mechanical limit switch with contacts
4. Auxiliary contacts
5. Manual winding spring

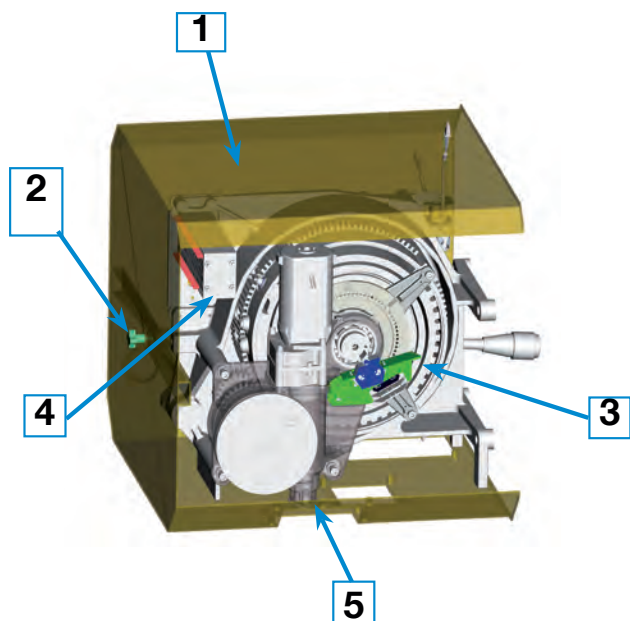


Fig. C. Operating Device Cubicle

## 2.2 Driving Mechanism (Fig. D)

### 2.2.1 Driving mechanism without cubicle (Fig. D)

Legend:

1. OPEN latch
2. CLOSE latch
3. Draft
4. Opening damper
5. Auxiliary contacts
6. Limit switch contacts
7. Frame
8. Closing spring (spiral spring)
9. Spring container (drum)
10. Driving Unit
11. Motor, spur gears transmission and worm gears transmission
12. Control pull-rod to circuit-breaker

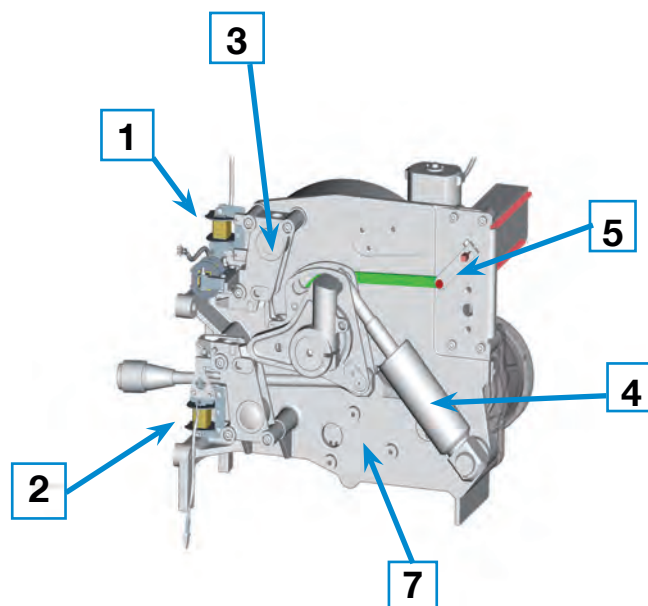


Fig. D. Driving mechanism without cubicle

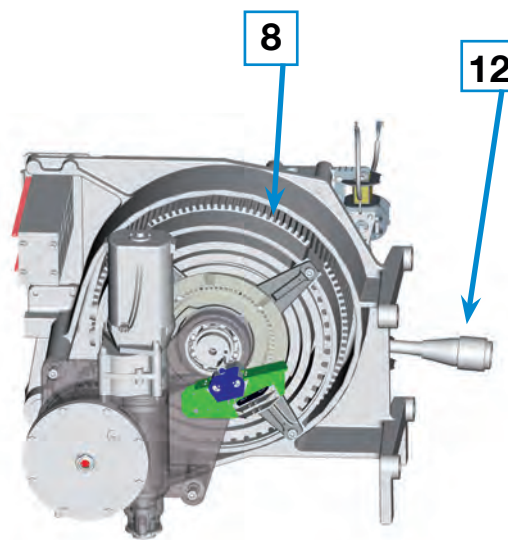
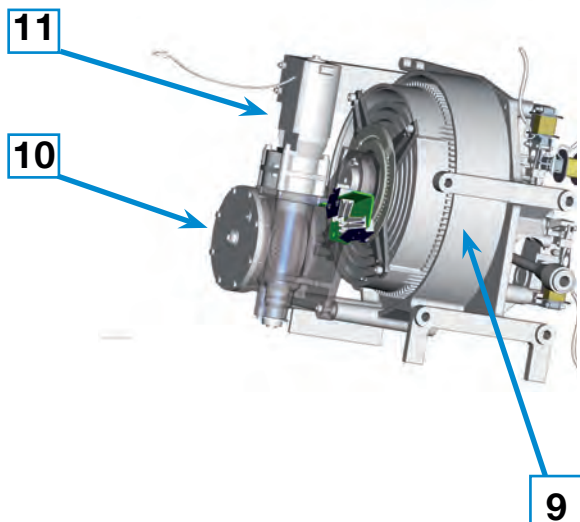
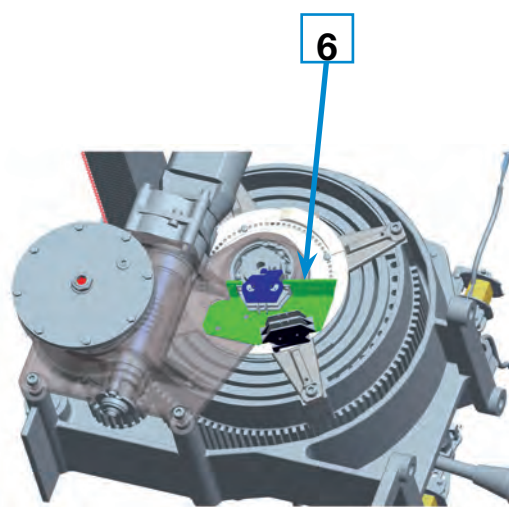


Fig. D. Driving mechanism without cubicle





**Fig. D. Driving mechanism without cubicle**



**Fig. D. Driving mechanism without cubicle**

The auxiliary equipment is characterized by the following main components:

- robust auxiliary contacts and limit switches;
- indication of charged, partly charged or discharged closing spring.

The housing of the spring operating mechanism is characterized by the following feature:

- corrosion resistant housing of painted aluminium.

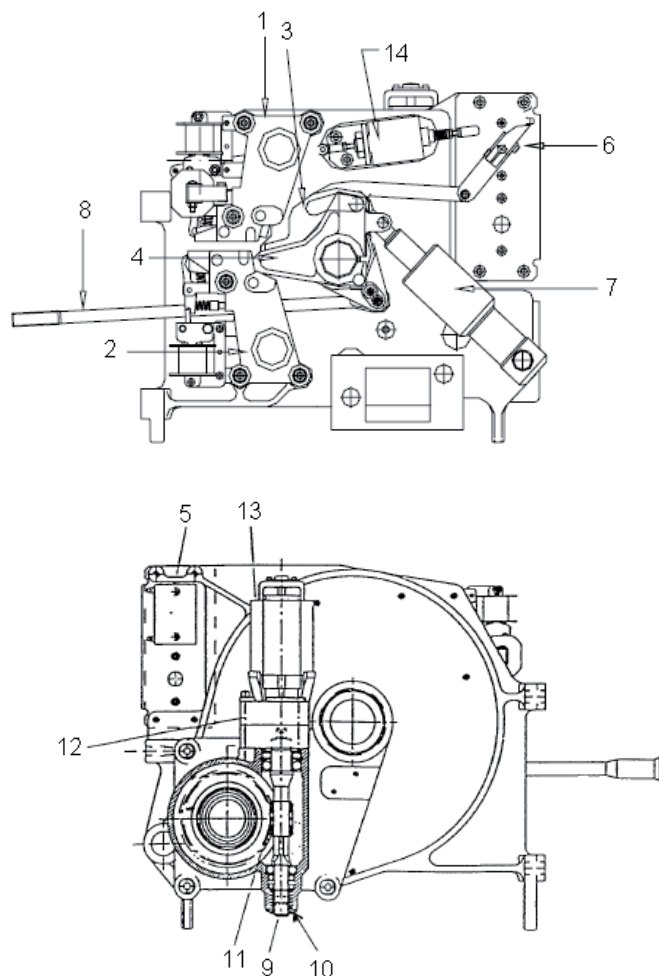
## 2.2.2 Operating Mechanism (Fig. E)

The Circuit Breaker is in a closed position with the closing spring charged.

**The Circuit Breaker opening spring is always charged when the circuit breaker is closed.**

**Fig. E Legend**

1. OPEN latch
2. CLOSE latch
3. Operating arm
4. Carrier
5. Auxiliary contacts
6. Drive auxiliary contact
7. Opening Damper
8. Control pull-rod to circuit-breaker
9. Shaft for manual charging of spring
10. Brake for discharging spring
11. Transmission with worm gears
12. Transmission with spur gears
13. Motor
14. Zero voltage trip latch (optional)



**Fig. E. Operating Mechanism**

### 2.2.3 Driving mechanism sectioned through drive shaft (Fig. F)

Fig. F Legend

1. Frame
2. Driving shaft
3. Control arm
4. Carrier splined to driving shaft
5. Spring container (drum)
6. Closing spring (spiral spring)
7. Motor
8. Transmission with worm gears
9. Transmission with spur gears
10. Control pull-rod to Circuit Breaker

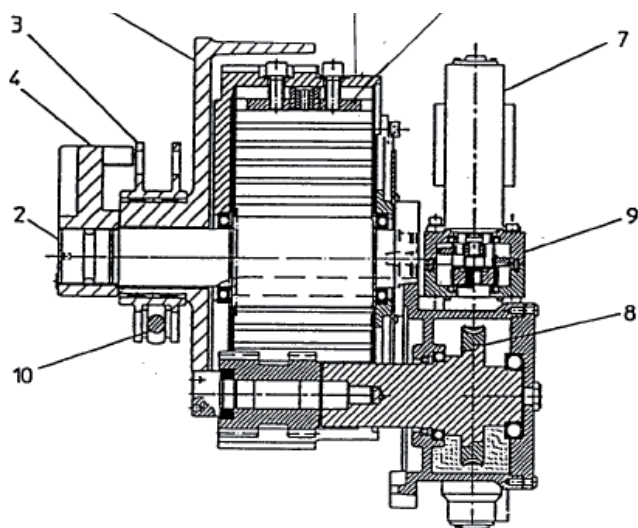
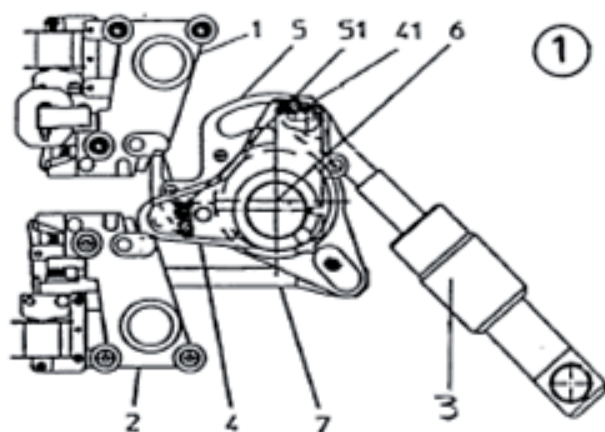
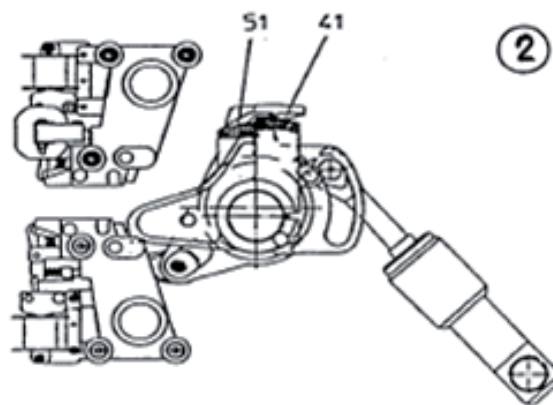


Fig. F. Driving mechanism. Section through drive shaft

### 2.2.4 Driving mechanism operations (Fig. G)



**Position 1:**  
Circuit breaker in **CLOSED** position. Closing spring charged. Opening spring charged.



**Position 2:**  
Circuit breaker in **OPEN** position.  
The damper has damped the circuit breaker's contact movement.

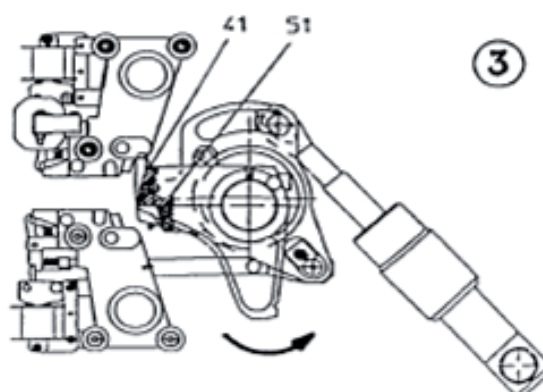


Fig. G. Driving mechanism operations

**Position 3:**  
Circuit breaker after closing, prior to spring charging.  
Support 4 and catch dog 41 are free from Arm 5 and from catch dog 51. The damper piston is fully extracted and is ready for an opening operation. The motor starts and re-charges the closing spring, after which position 1 is reached and the operating device is ready for a new closing operation.

## 2.3 Electrical Equipment (Fig. H)

Fig. H Legend

- Y1. Opening operation coil 1
- Y2. Opening operation coil 2
- Y3. Zero voltage opening operation coil (where fitted) option
- Y4. Closing operation coil
- M. Motor
- S2. Motor stop limit switch
- S2. Motor start limit switch
- S1. Auxiliary contacts
- S4. Isolator switch to the motor circuit for manual charging of closing coil
- R1. Anti-condensation heating
- X1. Terminals

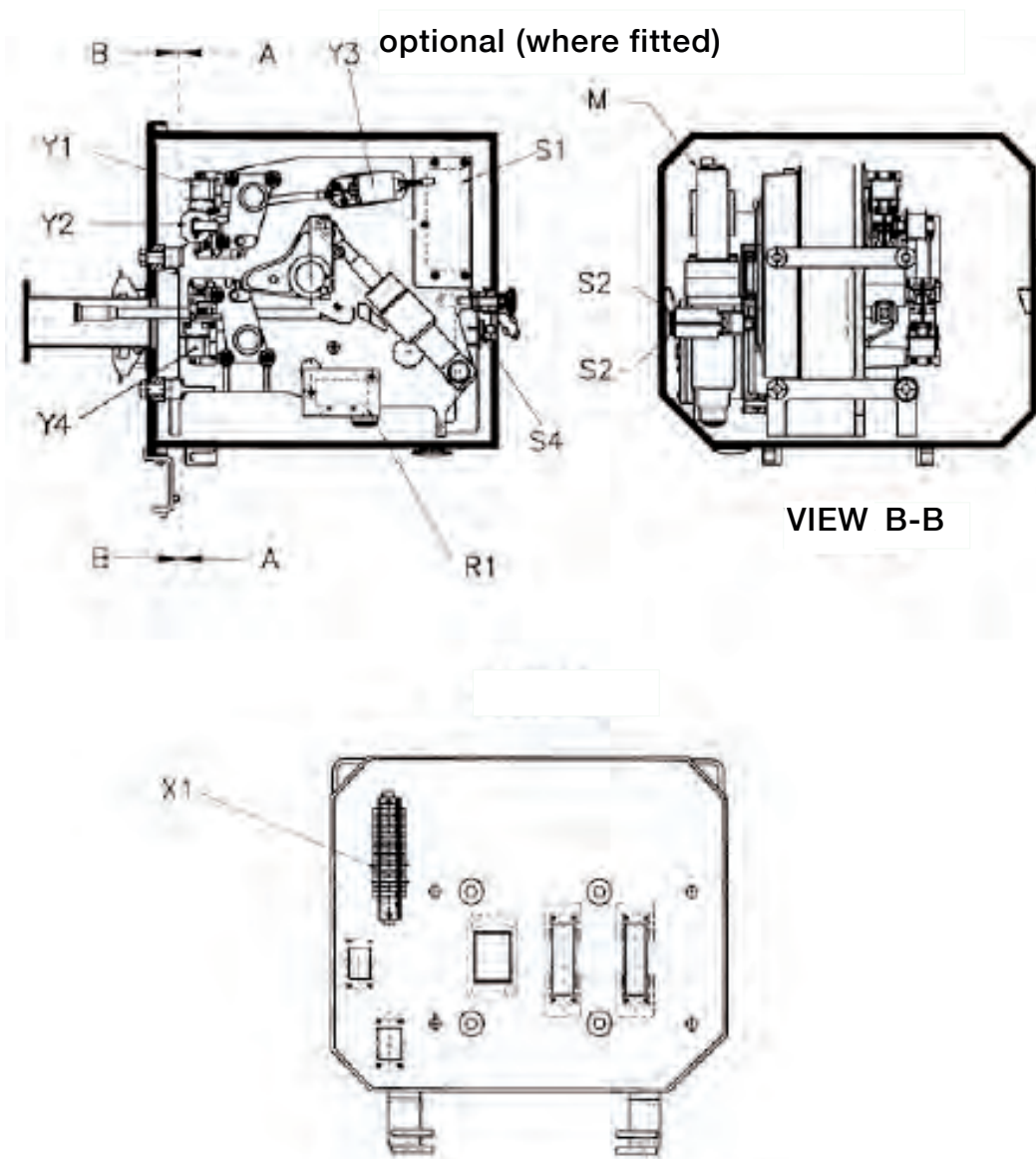


Fig. H. Electrical Equipment lay out

## 3. Operation

### 3.1 Normal Operation

#### 3.1.1 Remote/Local operations from the control room control panel

The selector switch, located in the control cubicle, allows to select the control mode.  
The local position enables the opening and closing buttons located in the control cubicle.

#### 3.1.2 Closing operation

The following conditions must be satisfied to perform a closing operation using the push-button, or remote electric impulse:

- Selector switch must be in the remote or local position.
- Closing operation spring must be fully charged.
- The Circuit Breaker must be in the OPEN position.
- The gas density must be higher than the locking level.

### 3.1.3 Opening Operation (Fig. I)

Opening can be performed locally with the Circuit Breaker in the CLOSED position, with the selector switch in the local position and by activating any one of the opening coils using the relevant push-button.

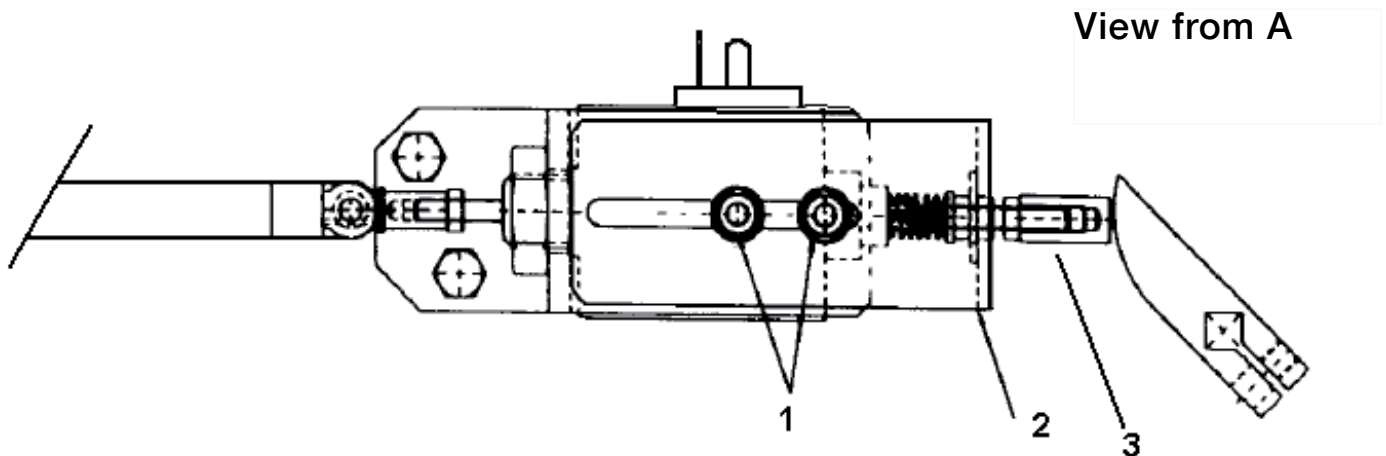
If the control is equipped with a zero voltage opening coil operation Y3 (Fig. H) this may be de-activated by loosening screws (1) and moving plate (2) against the mobile anchor (3) to prevent the spring action. Then re-tighten screws 1.



**WARNING:** ensure when performing either 3.1.2 or 3.1.3 (above) that Y3 is mechanically de-activated or energized with the circuit breaker in the opening position and the closing spring discharged.

Fig. I Legend

- 1. Nut
- 2. Clamping Plate



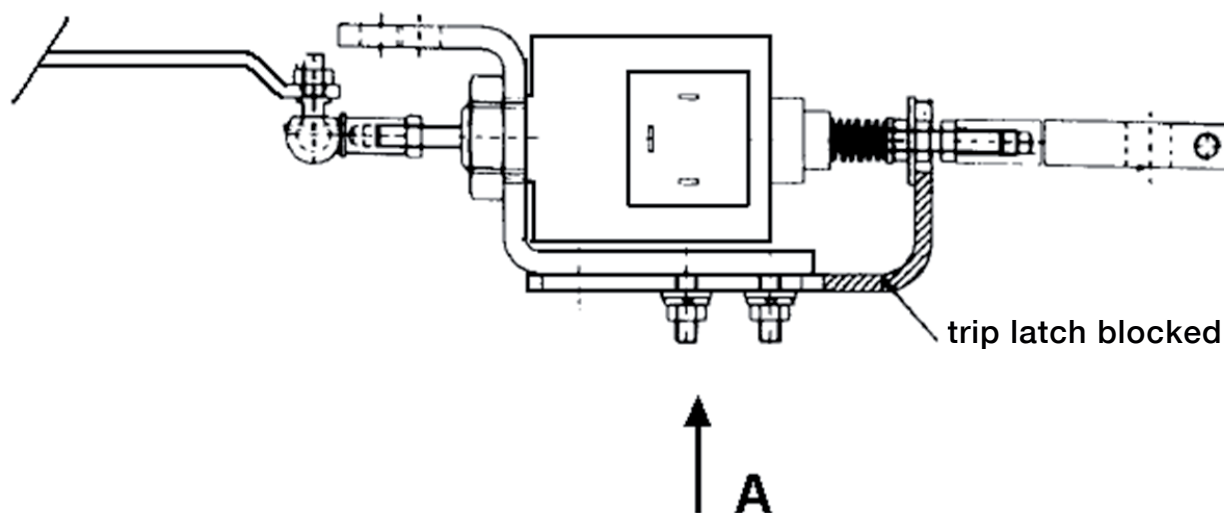
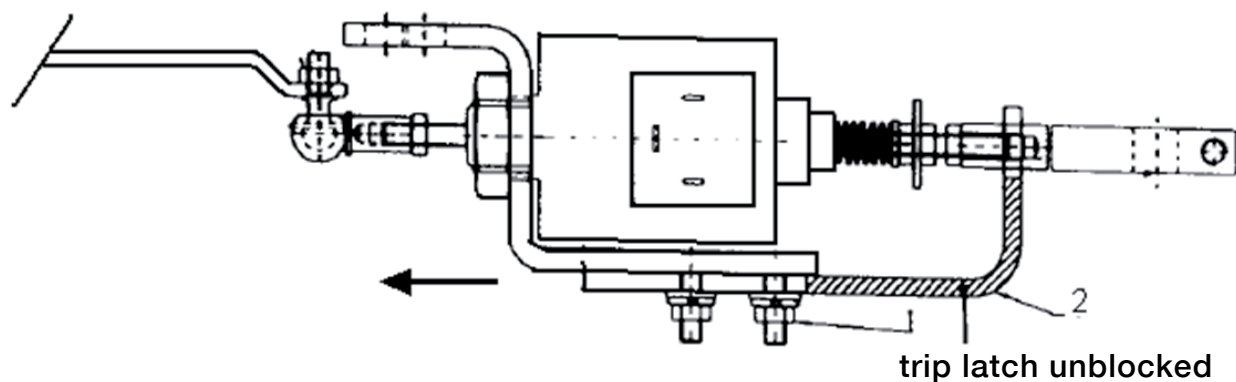


Fig. I Zero Voltage opening operation coil

### 3.1.4 Rapid auto re-closing operation

The automatic rapid re-closing operation OPEN-0.3s-CLOSE-OPEN can be performed in the following conditions:

- The Circuit Breaker is in the closed position.
- The closing spring in the operating device is fully charged when the operating cycle starts.

Since the control circuits are interlocked using the auxiliary contact S1 (fig.H), a closing operation will always be finished before an opening operation starts.

### 3.2.1 Motor powered charging

Close the motor protection switch, to supply the motor circuit, in the control cubicle to start the charge of the closing spring (when allowed). Supply the auxiliary contacts. The motor starts and drives the spring container to the charge position, until the limit switches S2-S4 (fig.H) break the contactor and open the motor circuits.

If a closing operation takes place, the limit switches S2-S4 close contactor KM and the motor circuits, and a new spring charging cycle starts.

### 3.2.2 Manual charging and discharging of the spring control drive

## 3.2 Charging the closing spring

The closing spring is normally charged electrically. Manual charging is possible.



**WARNING:** the manual charge of the spring is an emergency operation. Read carefully and entirely the steps, before operating.

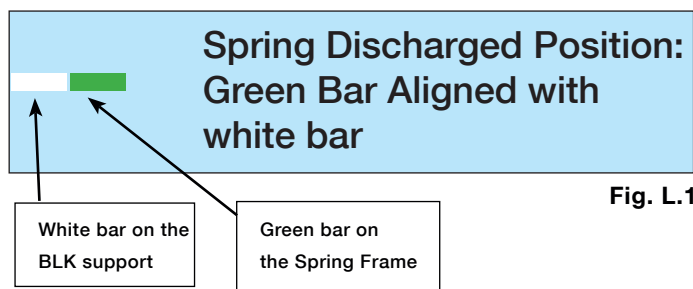




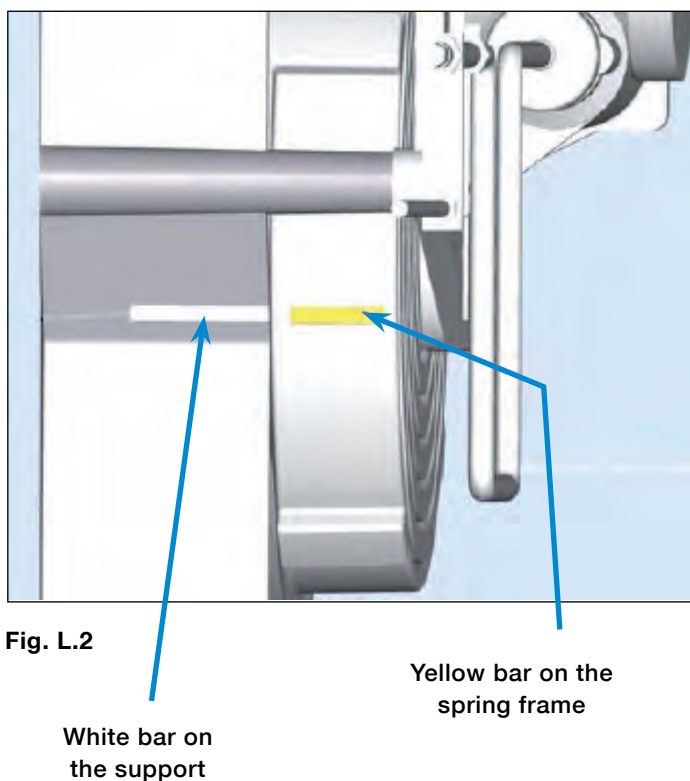
**WARNING:** the manual charge of the spring is an emergency operation. Read carefully and entirely the steps, before operating. Before carrying out the manual charge/discharge, disconnect the motor. Motor's contactor KM must not be acted manually. Open the back cover (fig. A.1).

#### Utilization of crank for manual charge

- The spring must be uncharged (fig. L.1);
- Disconnect the feed of the motor powered charging.

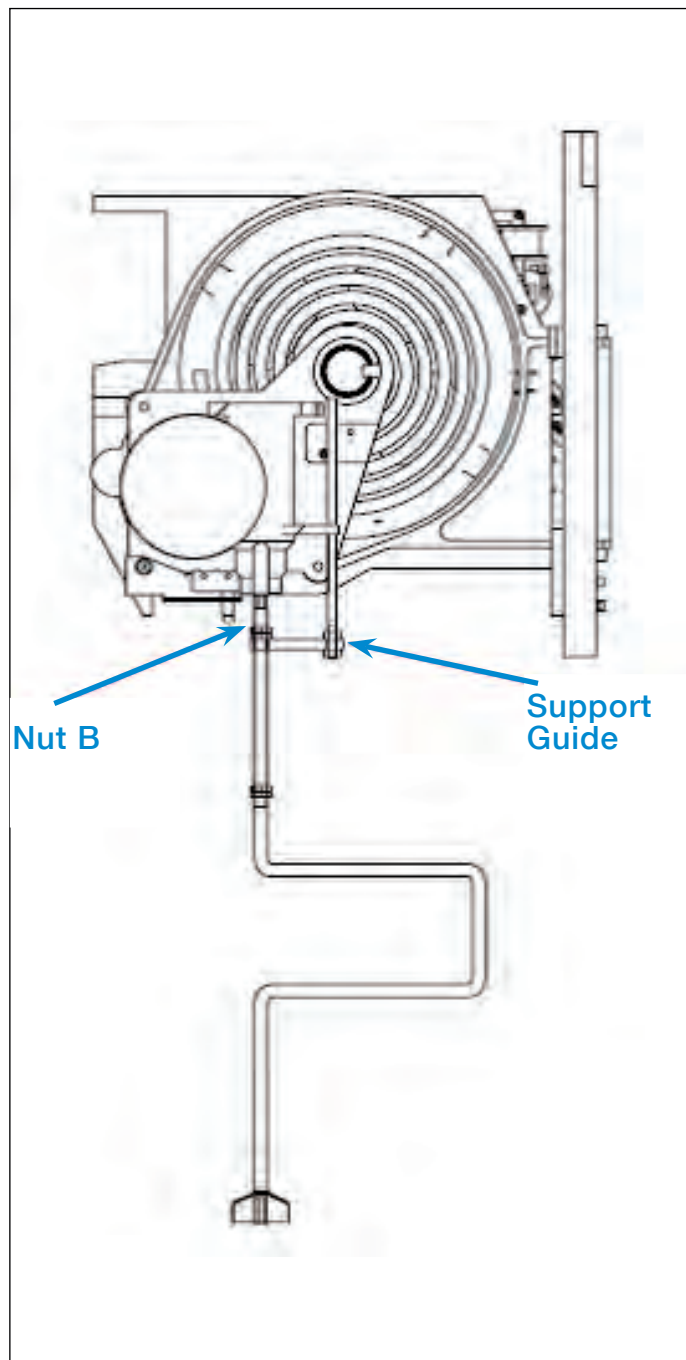


- Line up, to white bar on the support, the yellow bar over the spring container (Fig. L.2).



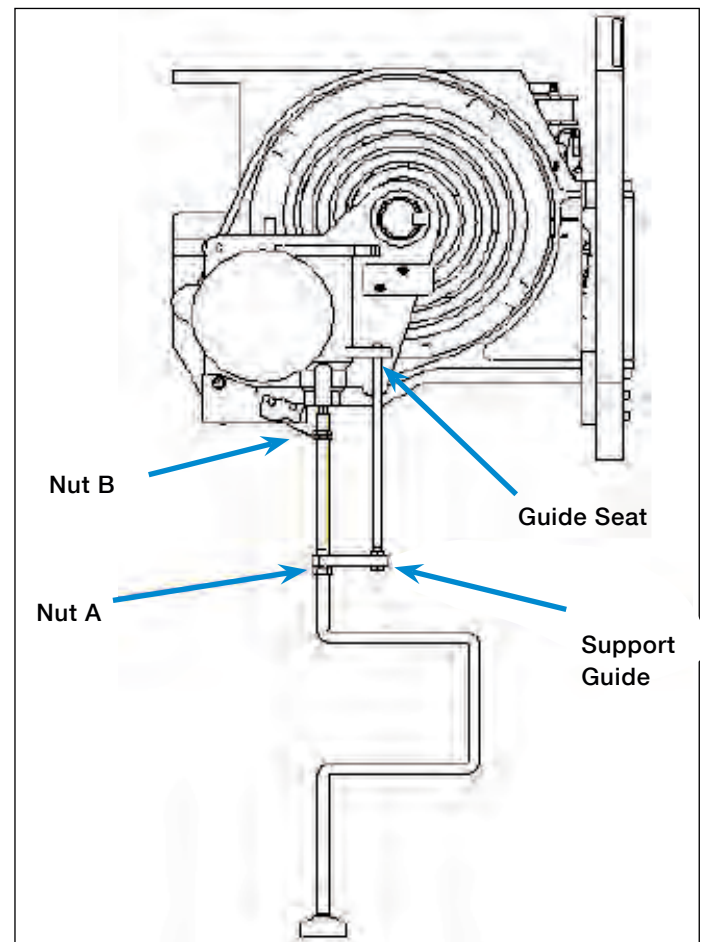
- Insert the crank in the “discharging side” and charge the spring by turning counterclockwise until the zero voltage position is reached.
- Once the yellow and white bars are aligned, extract the crank, turn and re-insert it in the “charge side” and insert it, side charge.
- Position the support guide, pushing it in order to beat the guide supports against the nut A (Fig. L.3).

**Fig. L.3**



- Turn the crank counterclockwise (view from under drive BLK), until the guide support reaches the nuts B (Fig. L.4).

**Fig. L.4**



- At the end, check that the red bar is lined up to the white bar (Fig. L.5).

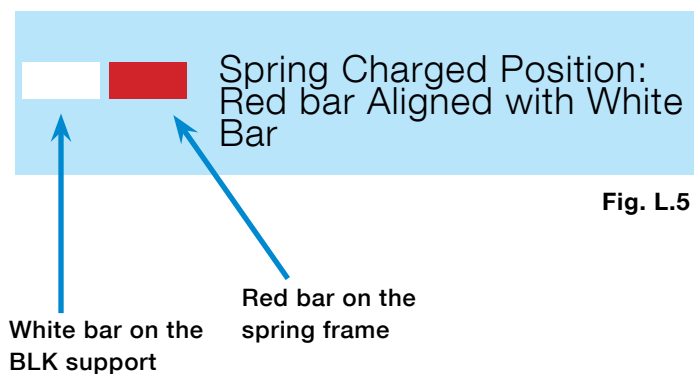


Fig. L.5

- Without overshoot it (Fig. L.6)

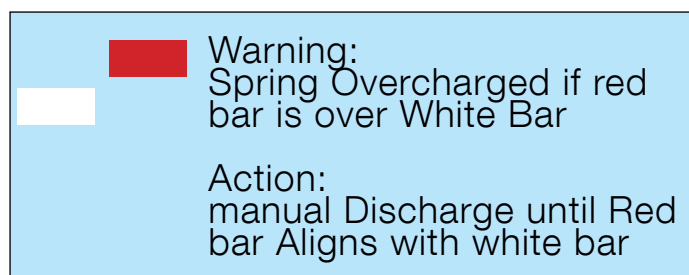


Fig. L.6

- In the case described above, discharge the spring until white and red bars are aligned (Fig. L.5). This is the last operation possible using the crank side discharge (Fig. L.7).



Fig. L.7. Terminal end of crank, to discharge the closing spring of BLK

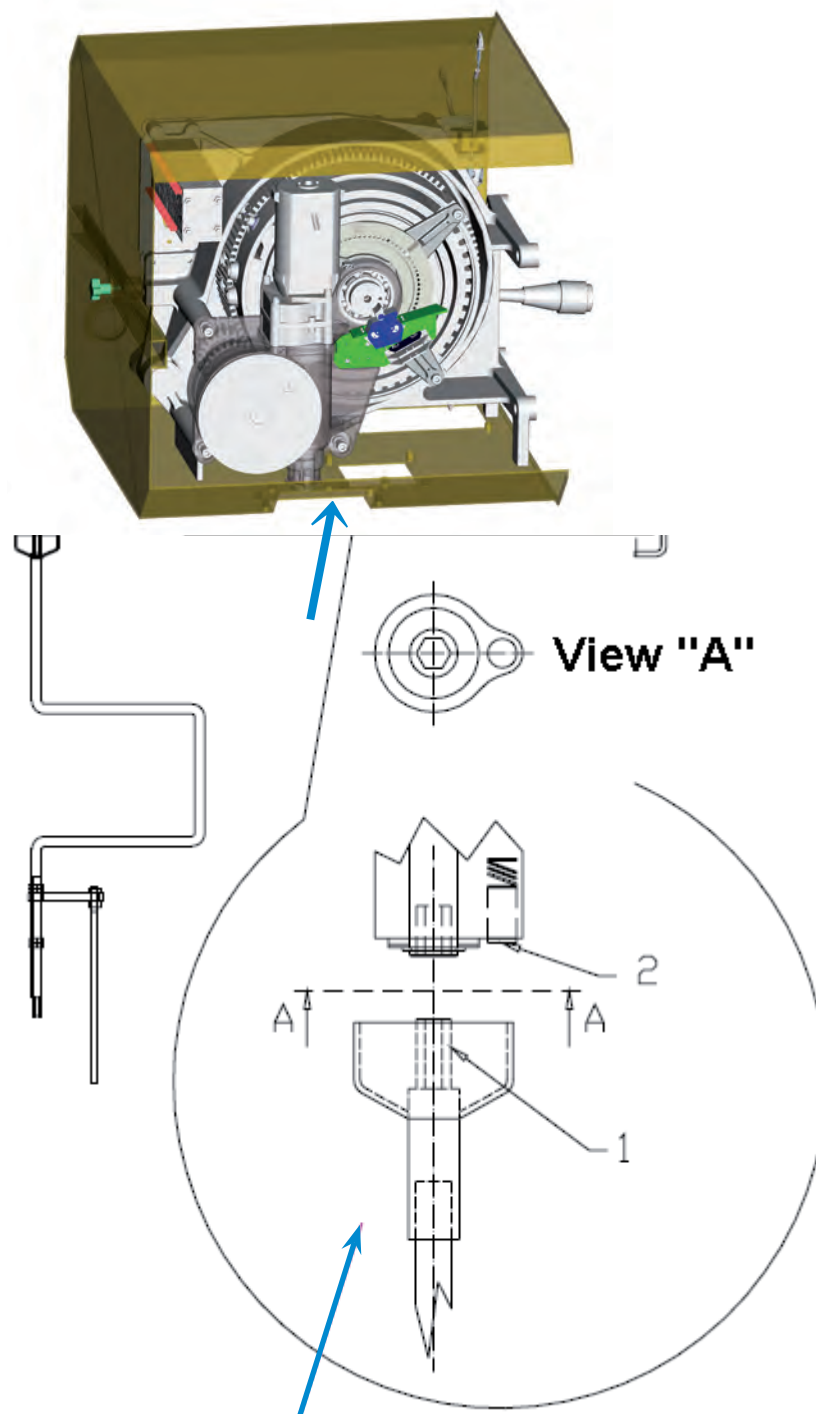


**WARNING:** the manual discharge of the spring is an emergency operation. Read carefully and entirely the steps, before operating.

### 3.2.3 Manual Discharge of the crank

- Switch off the motor protection F1 in the control cubicle;
- Switch off auxiliary voltage of control circuit;
- Open the back cover (Fig. A.1);
- Insert the crank (fig. L.8) into hexagonal socket and press the button (2); discharge the spring by turning the crank with clockwise rotation (view from bottom), pay attention to relieve the spring.





End of the crank, to download the closing spring of the BLK

**Fig. L.8**

- Totally discharged spring is indicated when the roller releases the drive, (fig. M)
- And the spring charge indicator shows that the spring is fully discharged.



**NOTE:** Button 2 (Fig. L.8) must be pressed



**WARNING:** Never release brake 2, until the manual discharge process is complete



**WARNING:** MANUAL DISCHARGING REQUIRES ATTENTION. THE ACTING TORQUE, IF NOT PROPERLY SUPPORTED, CAN CAUSE A DANGEROUS AND FAST ROTATION OF THE HAND CRANK.

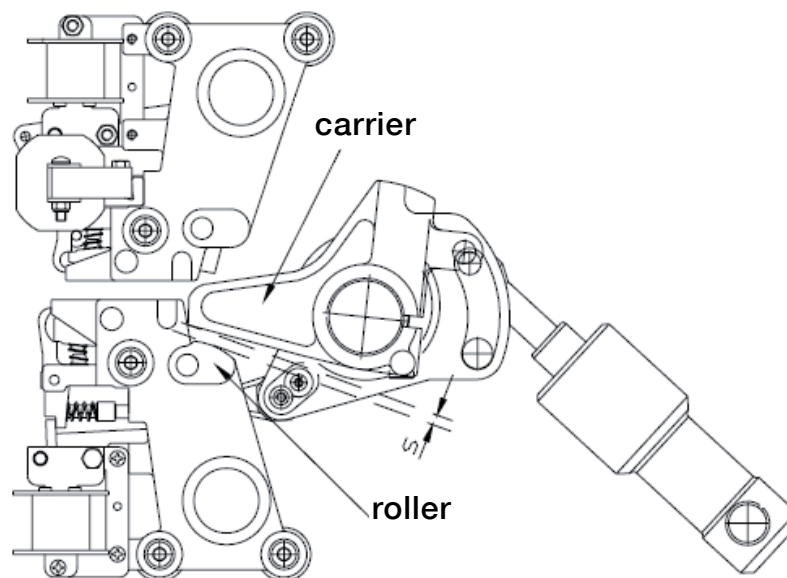


Fig. M. Discharged spring

### 3.3 Discharging of the closing spring



**IMPORTANT: Always discharge the closing spring before starting maintenance work on the Circuit Breaker or on the operating device.**

#### 3.3.1 Discharge by command

- Switch off the motor protection switch F1 in the control cubicle.
- Position selector switch in the control cubicle to local.
- Perform a sequence of OPEN-CLOSE-OPEN operations.
- Check the position of spring means color signs from window, under drive cover (A.1).

### 3.4 Interlocking system

The following electrical interlocks are installed in the centralized control cubicle and in the control device.

**Closing circuit: (to be read in conjunction with schematic diagram)**

- The closing impulse, which passes through the NC auxiliary contact (closed when the Circuit Breaker is open) only reaches the closing coil Y4 if the Circuit Breaker is open.
- The closing impulse reaches the closing coil Y4 by

passing through a spring charging limit switch contact which is closed only when the spring is charged.

- The closing impulse is stopped if the SF6 gas density is lower than the blocking level during any phase.
- A prolonged closing impulse is interrupted by the anti-pumping relay after the closing operation has been completed.

### 3.5 Heating

Energize the heater by closing the heating circuit protection switch in the control cubicle.

## 4. Maintenance

### 4.1 General

Refer to "PREVENTIVE MAINTENANCE GUIDE".

### 4.2 Lubrification

Lubricate latch (1) and latch (2) (Fig. E) using grease L after 2.000 operations. (See appendix A at the end of this manual).

### 4.3 Actions after periodic inspection

Faults and anomalies, as well as deviations from functional values noted during periodic inspections can be corrected, for example, by cleaning, tightening, adjusting or lubricating, or may be regarded as more serious and require corrective maintenance. This maintenance does not require immediate intervention, but can be scheduled for an appropriate time.

## 4.4 Faults during operation

Faults that occur during operation and that can cause the Circuit Breaker to breakdown must, as a rule, be corrected immediately. Before adequate measures can be taken, the type of fault and its possible cause must first be analyzed.

## 4.5 Analysis of deviations or faults

Type of faults	Possible reason for anomaly or fault	Corrective measure in order of priority
<b>1. Operation times too long at CLOSE and OPEN operations.</b>	<ul style="list-style-type: none"> <li>- Control voltage too low</li> <li>- Catch gear sticks</li> </ul>	<ul style="list-style-type: none"> <li>- Check control voltage</li> <li>- Check the minimum control voltage. If this exceeds the original value by more than 20%, the catch gear must be checked and if necessary, lubricate with grease "L".</li> </ul>
<b>2. Minimum control voltage too high</b>	<ul style="list-style-type: none"> <li>- Catch gear sticks</li> </ul>	<ul style="list-style-type: none"> <li>- Check catch gear</li> <li>- Lubricate with grease "L"</li> </ul>
<b>3. Time differences between poles</b>	<ul style="list-style-type: none"> <li>- Deviation in some operating device at single pole operation.</li> <li>- Link system loosened.</li> <li>- Worn arcing contacts.</li> </ul>	<ul style="list-style-type: none"> <li>- Check catch gear</li> <li>- Lubricate with grease "L".</li> <li>- Comply with circuit-breaker fault analysis</li> </ul>
<b>4. Circuit-breaker does not operate at impulse to OPEN</b>	<ul style="list-style-type: none"> <li>- No control voltage</li> <li>- Open control circuit interrupted</li> <li>- Control circuit interrupted</li> <li>- Opening catch gear sticks</li> </ul>	<ul style="list-style-type: none"> <li>- Check position of selector switch located in the centralised control cubicle</li> <li>- Check control voltage</li> <li>- Check the pressure/density gauge 63GB</li> <li>- Check the blocking relay K3, K2</li> <li>- Check control circuit</li> <li>- Check opening catch gear</li> </ul>
<b>5. Circuit-breaker does not operate at impulse to CLOSE</b>	<ul style="list-style-type: none"> <li>- No control voltage</li> <li>- Closing impulse blocked</li> <li>- Catch gear sticks</li> <li>- Gas pressure too low</li> </ul>	<ul style="list-style-type: none"> <li>- Check position of selector switch located on centralised control panel</li> <li>- Check control voltage</li> <li>- Check pressure/density gauge 63GB</li> <li>- Check blocking relay K3</li> <li>- Check control circuit</li> <li>- Check spring closing limit switches S2, S3</li> <li>- Circuit-breaker control circuit</li> <li>- Check catch gear</li> <li>- Lubricate with grease "L"</li> <li>- Closing spring discharged</li> <li>- Check that switch F1 is on</li> <li>- Check the motor contactor KM</li> <li>- Check micro switch S4</li> <li>- Check motor voltage</li> <li>- Refill gas</li> </ul>
<b>6. Circuit-breaker operates without impulse to CLOSE or OPEN</b>	<ul style="list-style-type: none"> <li>- Short-circuit or connection fault in control circuit</li> <li>- Worn or broken catch gear</li> </ul>	<ul style="list-style-type: none"> <li>- Check control circuit according to circuit diagram</li> <li>- Test insulation</li> <li>- Check and change catch gear</li> </ul>

Tipo di anomalia o guasto	Possibile causa di anomalia o guasto	Misure correttive in ordine di priorità
<b>7. Circuit-breaker does not remain in CLOSED position at closing operation</b>	<ul style="list-style-type: none"> <li>- worn or broken catch gear</li> <li>- Opening spring is overcharged</li> <li>- Closing spring is insufficiently charged</li> </ul>	<ul style="list-style-type: none"> <li>- Check opening catch gear</li> <li>- See note 1 below</li> <li>- See note 1 below</li> </ul>
<b>8. Circuit-breaker closes again immediately after a CLOSE-OPEN operation</b>	<ul style="list-style-type: none"> <li>- Faulty anti-pumping relay</li> </ul>	<ul style="list-style-type: none"> <li>- Check control circuit</li> <li>- Check anti-pumping relay</li> </ul>
<b>9. Faulty damping time</b>	<ul style="list-style-type: none"> <li>- Oil leak in shock absorber</li> <li>- Shock absorber sticks</li> </ul>	<ul style="list-style-type: none"> <li>- Check shock absorber and replace if necessary</li> </ul>
<b>10. Charging time too long and motor currents too high greater than 15 seconds.</b>	<ul style="list-style-type: none"> <li>- Excessive friction in worm gear</li> <li>- Electric fault in motor</li> </ul>	<ul style="list-style-type: none"> <li>- Check oil level in the gear</li> <li>- Check control voltage</li> <li>- Change motor</li> </ul>
<b>11. Motor does not start at closing operation</b>	<ul style="list-style-type: none"> <li>- Motor protection tripped</li> <li>- No motor voltage</li> <li>- Fault in limit switch contact BW</li> </ul>	<ul style="list-style-type: none"> <li>- Check protection switch F1</li> <li>- Check micro switch S4</li> <li>- Check contactor KM</li> <li>- Check contact S2 - S3</li> </ul>
<b>12. Motor does not stop at fully charged spring</b>	<ul style="list-style-type: none"> <li>- Electric fault in motor circuit</li> </ul>	<ul style="list-style-type: none"> <li>- Check motor contactor KM</li> <li>- Check contact S2 – S3</li> </ul>
<b>13. Ice or condensate in the operating device</b>	<ul style="list-style-type: none"> <li>- Heater does not function</li> </ul>	<ul style="list-style-type: none"> <li>- Check heater operation R1</li> </ul>

Table.1. Analysis of deviations or faults

## 1) The Circuit Breaker does not remain in the closed position.

This may be due to insufficient energy provided by the closing spring due to an insufficient charge or to an overcharge of the opening spring.

Spring adjustments must be performed by our fully trained ABB SERVICE personnel.

## 4.6 Overhaul of operating device

### 4.6.1 Preparation

Read these instructions before opening the control device and follow the instructions during overhauling operations. All the applicable Electrical Industry Safety Regulations shall be strictly followed.



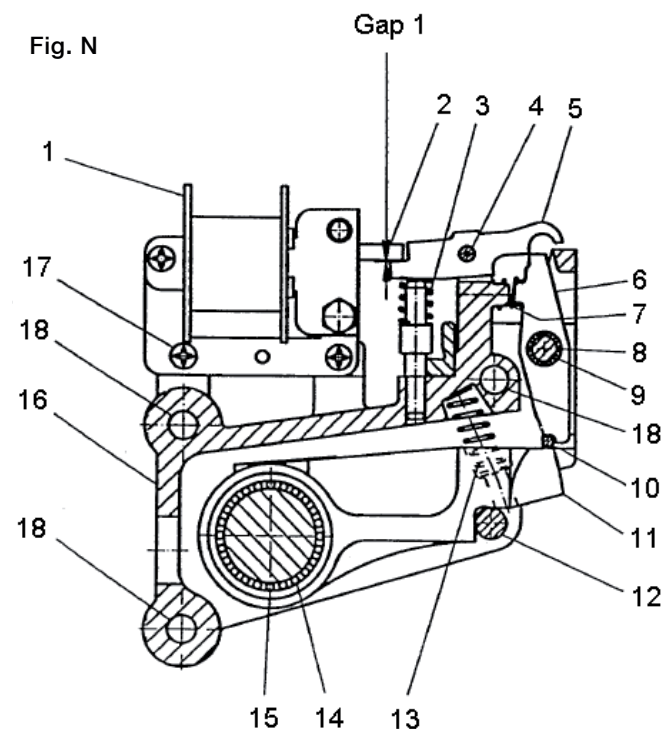
**WARNING:** Carry out the OPEN operation, disconnect and earth the Circuit Breaker's high voltage connections. Interrupt the control voltage, motor voltage and where applicable also the heater voltage before working on the control device. Discharge the closing spring.

Overhauling can be carried out on site with the control device mounted on the Circuit Breaker. All essential components can be dismantled for checking or replacement, if necessary.

### 4.6.2 Change of OPENING or CLOSING catch gear (Fig. N)

Fig. N Legend

- |                       |                                  |
|-----------------------|----------------------------------|
| 1. Electromagnet      | 10. Roller                       |
| 2. Armature           | 11. Main catch                   |
| 3. Spring             | 12. Roller                       |
| 4. Pin                | 13. Spring                       |
| 5. Auxiliary catch    | 14. Bearing                      |
| 6. Intermediate catch | 15. Shaft                        |
| 7. Spring             | 16. Catch holder                 |
| 8. Pin                | 17. Screw M5x20                  |
| 9. Bearing            | 18. Screw M8x70<br>(torque 50Nm) |



Replace the complete OPENING or CLOSING device by loosening the screws M18. Use the same screws when assembling the new catch gear.

4.6.3 Replacing catch gear in zero voltage conditions (Fig. O).

Loosen screws (2). Remove the catch gear from the control frame so as to loosen screw (3). Replace the catch gear and tighten screws (3) and (2).

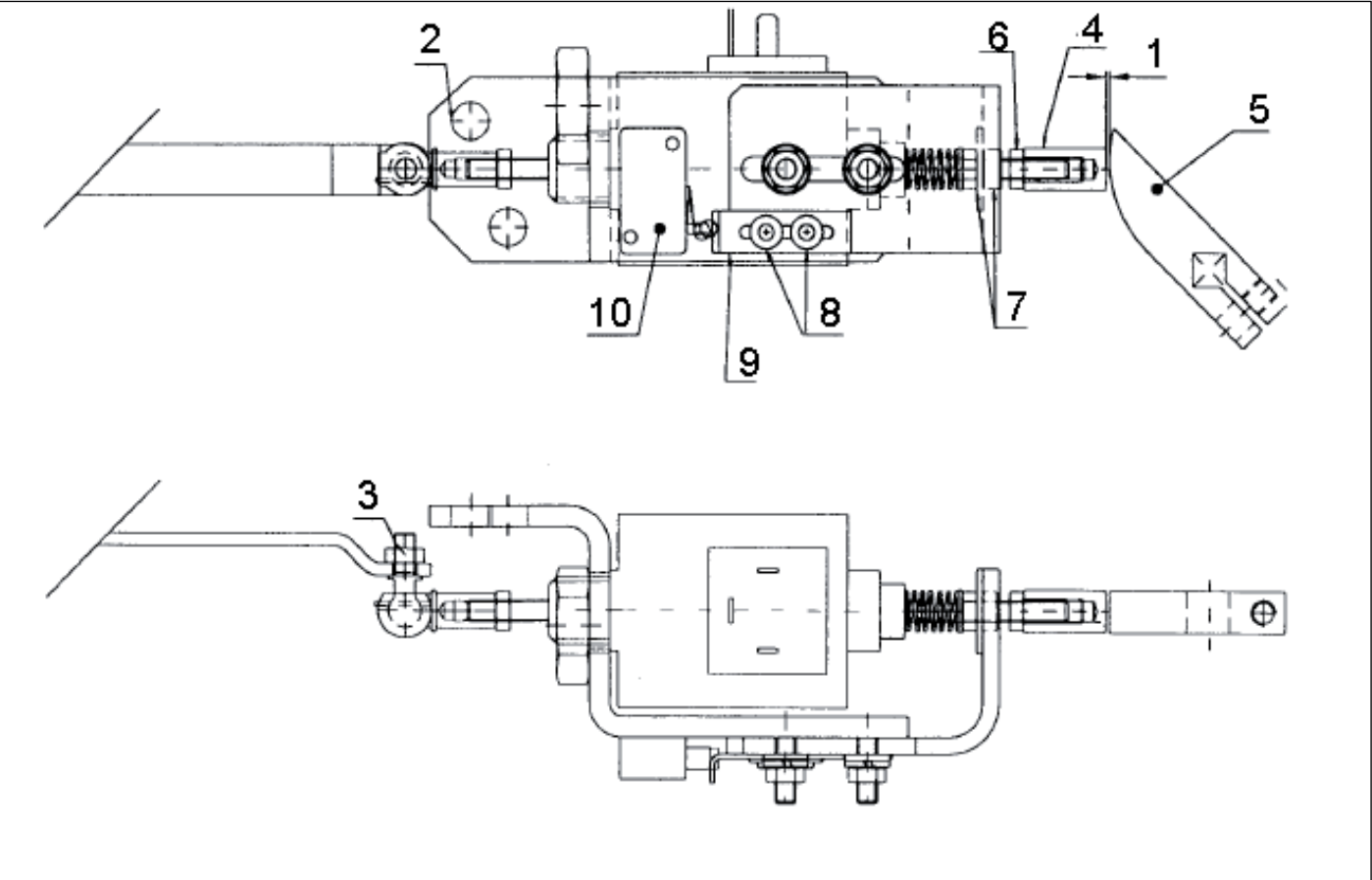
Adjust screw (4) so that the gap between the catch gear and the lever is 1 mm. Tighten, the voltage value be provided by an indicator micro switch, loosen screws (8) and move the holder (9) completely to the right.

Move the holder (9) against the micro switch (10) after having clamped the catch gear (see paragraph 3.1.3) so that it trips at a precise point. Tighten screws (8) and place the catch gear in the required position for clamped or inserted operation, as indicated in point 3.1.3.

Fig. O    Legend

- |   |                              |    |              |
|---|------------------------------|----|--------------|
| 1 | space between coil and catch | 6  | counter nut  |
| 2 | screw                        | 7  | screw        |
| 3 | nut                          | 8  | screws       |
| 4 | adjusting screw              | 9  | plate        |
| 5 | catch                        | 10 | Micro switch |

Fig. O



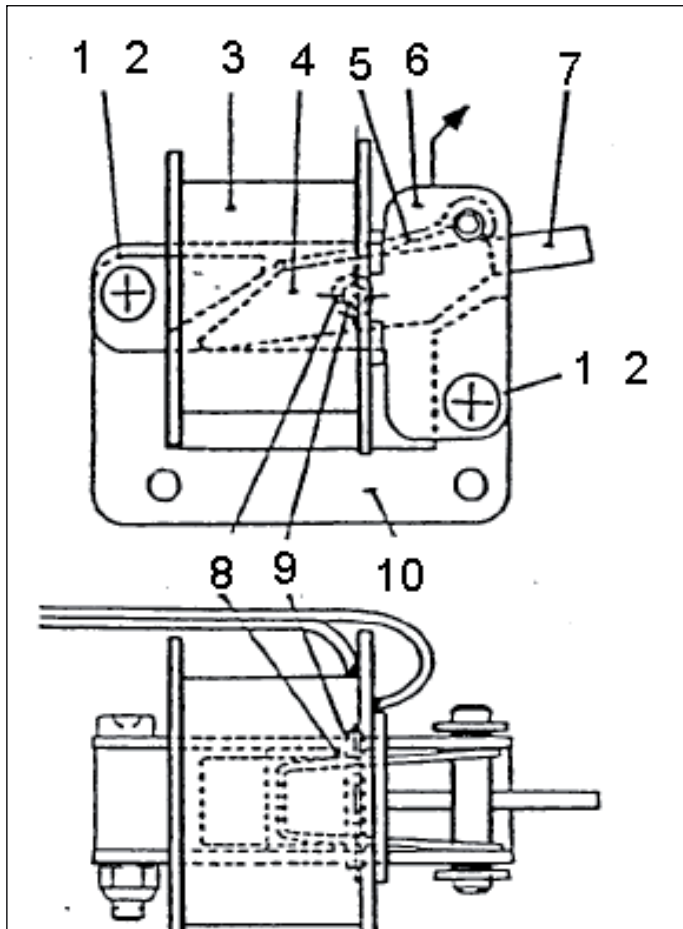
#### 4.6.4 Replacing coils in OPENING or CLOSING catch gear

Dismantle the electromagnet first by loosening screws M17 from the catch gear.

Fig. P Legend

- |     |                |
|-----|----------------|
| 1.  | Screw M6x30    |
| 2.  | Locking nut M6 |
| 3.  | Coil           |
| 4.  | Armature       |
| 5.  | Spring         |
| 6.  | Support plate  |
| 7.  | Arm            |
| 8.  | Washer         |
| 9.  | Pin            |
| 10. | Magnet Core    |

Fig. P



Replace coil as follows:

- Loosen locking nut (2) and remove screw (1).
- Pull the support plate (6), including the armature and coil, upwards and to the side as indicated by the arrow in the figure.
- Replace the coil, re-assemble the components in their original positions.
- Press arm (7) downwards with force, using a screwdriver as shown in fig. Q, before tightening locking nut (2, fig. P) to make the air gap as small as possible.

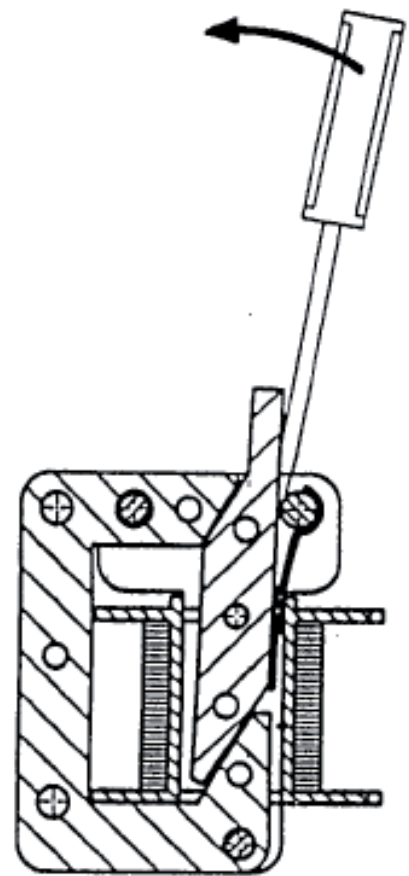


Fig. Q. Armature Adjustment

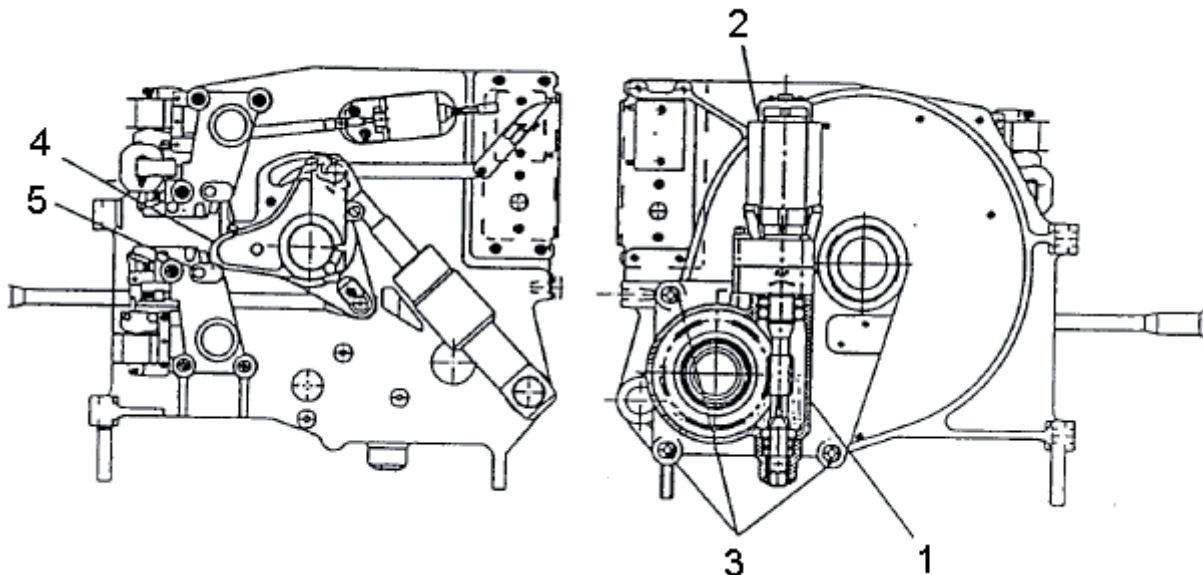
- Install the electromagnet in its seat on the catch gear (fig. N). The nominal gap between the electromagnet arm (2 fig. N) and the auxiliary catch (5 fig. N) is  $1 \pm 0,1$  mm. Tighten all screws (17 fig. N).
- Connect all coil wires.
- Re-assemble the OPENING and CLOSING catch gears in the control device.



## 4.6.5 Replacing of motor

**Fig. R Legend**

1. Motorized charging device
2. Motor
3. Screw M8x40 (Torque 50 Nm)
4. Carrier
5. Roller on close latch



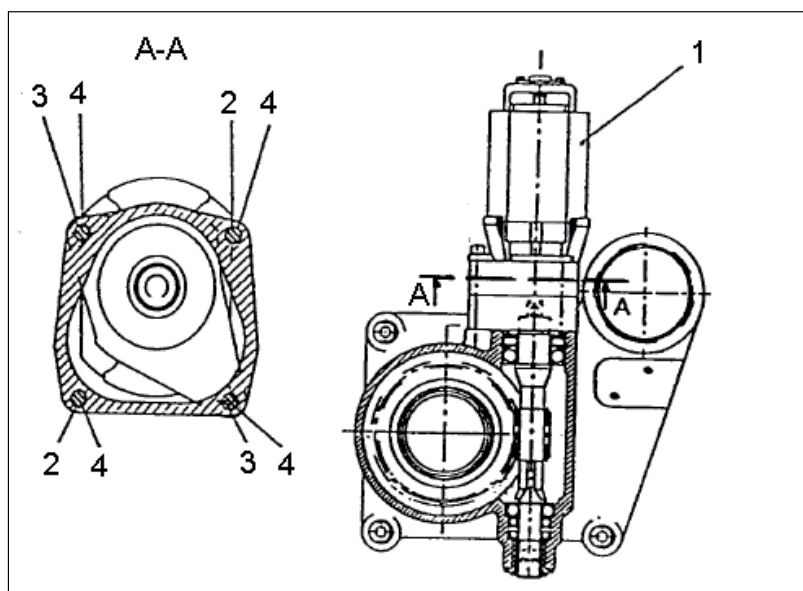
**Fig. R. Driving mechanism, front**

Isolate control device according to relevant Electrical Industry Safety Regulations

- Remove the operating device cover.
- Discharge the closing spring completely. The spring symbol is green to indicate the spring is discharged.
- Bring carrier (4 fig. R) in contact with roller (5 fig. R) by manually cranking in the direction of charging the closing spring.
- Loosen the two screws (3 fig. S) holding the motor.
- Disconnect the motor and lift it out.
- Install the new motor using the same screws. Tighten screws (3 fig. S).
- Connect the electric wires to the motor.

**Fig. S Legend**

1. Motor
2. Screw M6x70 9.6 Nm
3. Screw M6x75 9.6 Nm
4. Washer 6.4x12x1.5



**Fig. S. Motorized charging device**



## 4.6.6 Replacing the shock absorber



**WARNING: THE OPENING SPRINGS ARE PRE-CHARGED; THEY MUST BE DISCHARGED COMPLETELY BEFORE REPLACING THEM**

Carry out the work as follows:

1. Put the control device out of service according to the Safety Regulations.
2. Discharge the closing spring completely.
  1. Bring carrier (4 fig. T) in contact with roller (6 fig. T), by manually cranking in the direction of charging the closing spring.
2. Loosen screw (1 fig. T).
3. Pull out pin (2 fig. T).
4. Loosen locking ring (3 fig. T).
5. Pull the shock absorber towards (9 fig. T) and lift it out.
6. Re assemble the new shock absorber following the procedure above in reverse order.

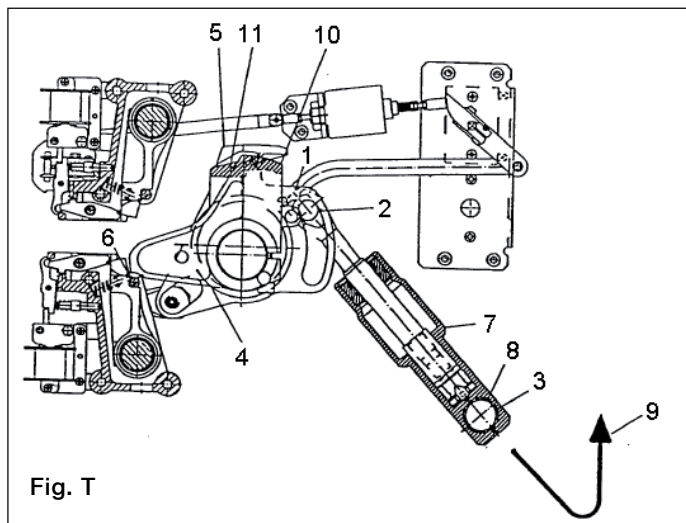


Fig. T Legend:

1. Screw M8x12
2. Pin
3. Locking ring
4. Carrier
5. Operating arm
6. Roller
7. Shock absorber
8. Pin
9. Direction for pulling out
10. Catch dog on carrier 4
11. Catch dog on arm 5

## 4.6.7 Checks and reconnection

When the work is finished, check that:

- All parts have been re-assembled in the correct way.
- All loose screw connection have been tightened to the set torque and, where applicable, locked according to instructions.

Then:

- Remove all tools.
- Connect the control voltage, motor voltage and heating voltage.

The control device is now ready to undergo functional tests with the circuit-breaker.

# 5. Testing and restart after overhaul

Perform functional tests and restart according to the instructions for assembly, testing and commissioning.

# 6. Necessary Equipment

## 6.1 Lifting tools and equipment

- A kit of ordinary tools with torque wrenches (10 – 300 Nm).
- A measuring toll (tape).
- Lifting straps 250 kg.

## 6.2 Cleaning and lubricating equipment

- Metal brush
- Polishing cloth
- Non-fraying rags
- Solvent
- Lubricants according to 5409 506E information:
  - o grease “G” to prevent rust and to lubricate mechanism parts.
  - o grease “L” to lubricate the CLOSING and OPENING catch gear mechanism parts
  - o grease “M” to lubricate the worm gears.

## 6.3 Testing Equipment

- Control cables for protected locations.
- Operating time measuring equipment with variable control voltage.
- Stop watch.

## 6.4 Locking Liquid for threads

- Agent "B": Loctite 242

# 7. Optional equipment

## 7.1 Manual operating device

The drive BLK can be equipped with a device, on request, for the manual operations OPEN, CLOSE (see fig. U, pos. 1, 2, 3, 4).

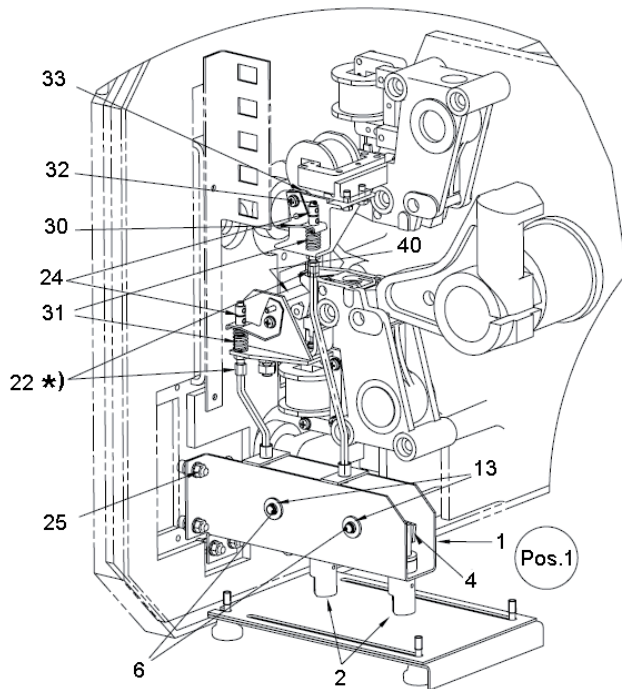


Fig. U. Position 1

### Fig. U Legend

- 1. Push button support
- 2. Push buttons
- 4. Lever
- 5. Pin
- 6. Pin
- 13. Ring
- 22. Adjustment
- 23. Bushing
- 24. Cable clamp
- 25. Fitting screws
- 30. Roller Plate
- 31. Spring
- 32. Frame
- 33. Trip lever
- 40. Closing lever

note: \*) Adjust the length of wire of the OPENING-CLOSING devices:  
DO NOT TOUCH items shown in Pos.3).

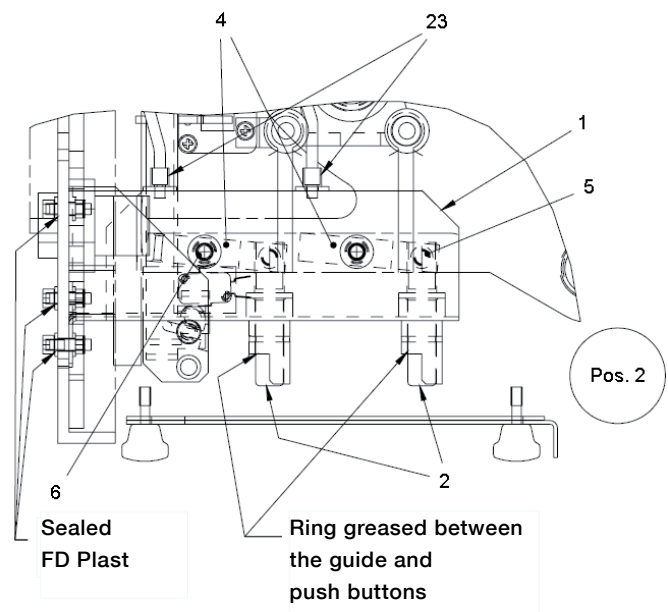


Fig. U. Position 2

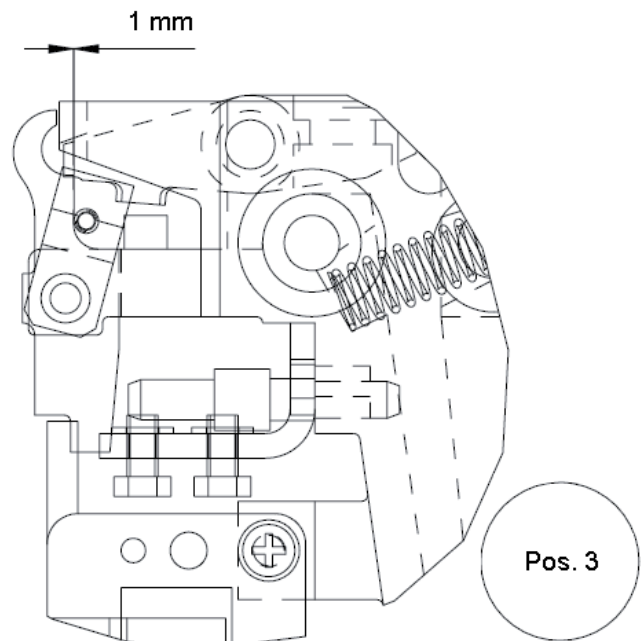


Fig. U. Position 3

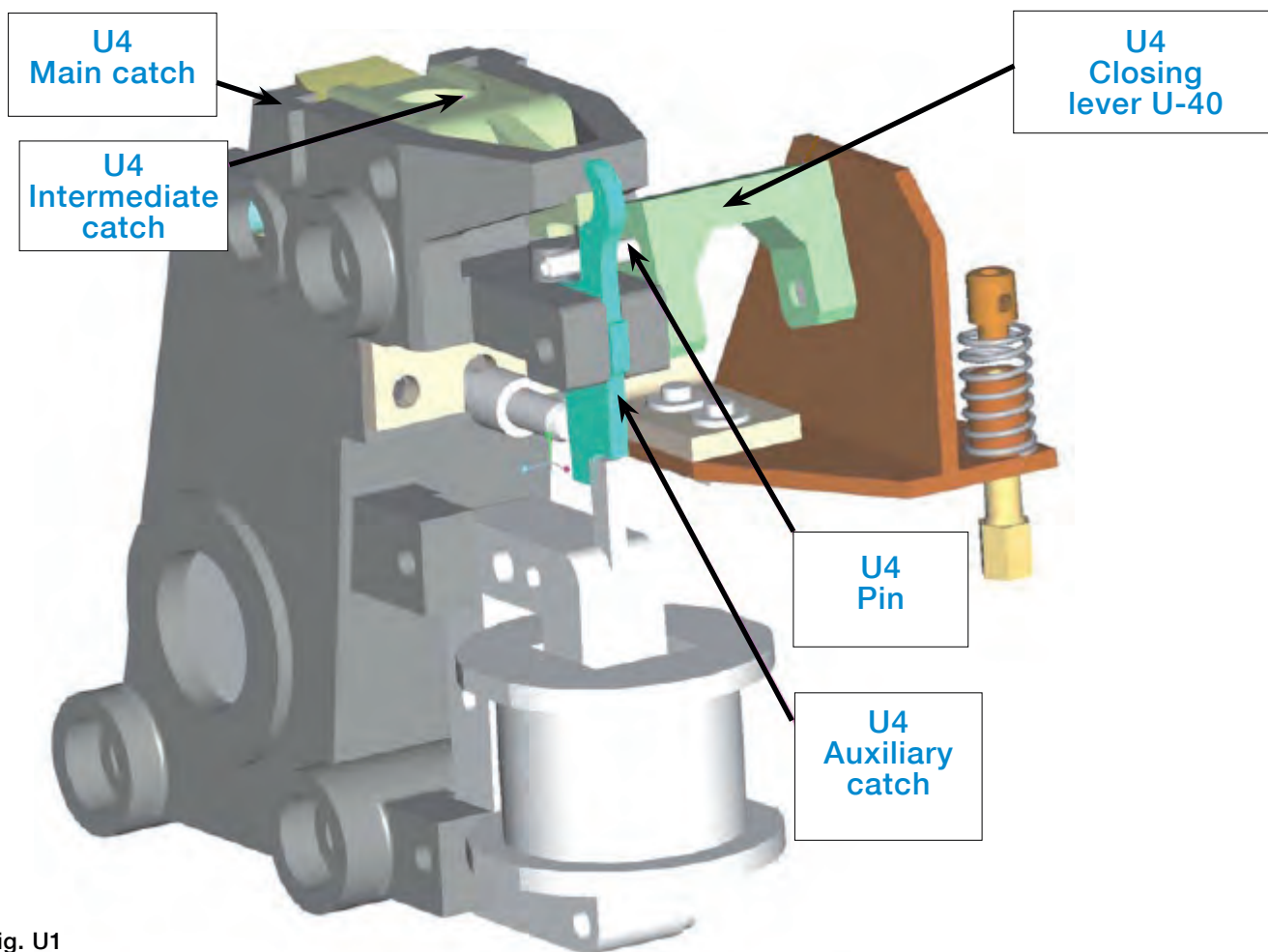


Fig. U1

An action on closing push button (2 fig. U) (pos. 1-2) rotates the lever (4 Fig. U) and, consequently, the wire is pulled. This turns the roller plates (30 fig. U) that rotates the closing lever (40 fig. U) (pos. 4), with little eccentric motion that is transmitted to the pin (U pos 4) in the same way. The auxiliary catch moves and releases the intermediate catch that lets the main catch move; the carrier is free to rotate. This starts the closing operation. The opening operation is similar.

## 7.2 Opening block

The drive BLK can be equipped with a device, on request, for the Opening block (see figure V) (for calibration of this device the closing spring must be discharged and the breaker open).

Fig. V Legenda

1. Support
2. Transmission
3. Transmission
4. Lever
5. Support
6. Pin
8. Block
9. Micro switch
10. Regulating screw
15. Pin
17. Screws
18. Stop ring
19. Padlock

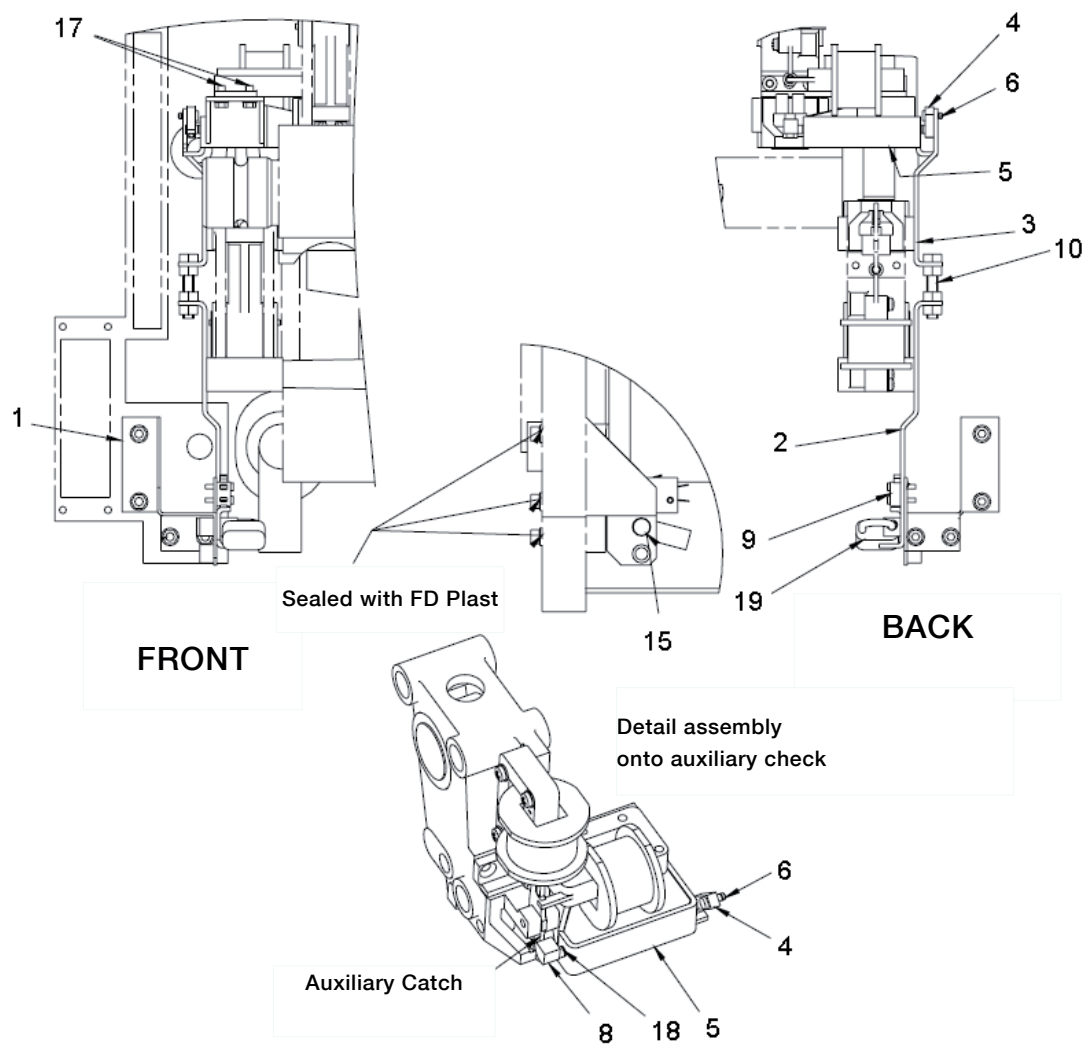


Fig. V Opening Block Device

With the support (1), (5) mounted, assemble the transmission (2) and fit it by the pin (15) (upper hole as in picture).

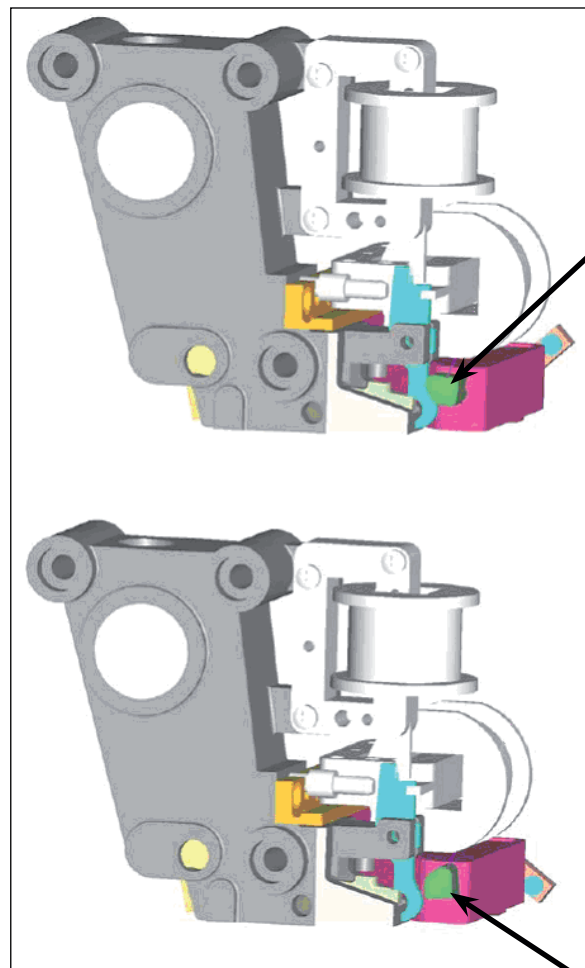
Pull the transmission (3), carrying up the block (8) against the auxiliary catch.

In this position join together the transmissions (2) and (3).

Make sure that the block (8) is pressed against the auxiliary catch.

Verify that micro switch is pressed, eventually adjust the screws.

After adjustment, with the device in BLOCKED position, the BLK device does not open when the coil is energized.



**Fig. V**

With the pin 15 in the upper hole the BLOCK 8 is against the auxiliary catch: Open operation is blocked. The transmission 2, 3 can be locked by a padlock

**Fig. V**

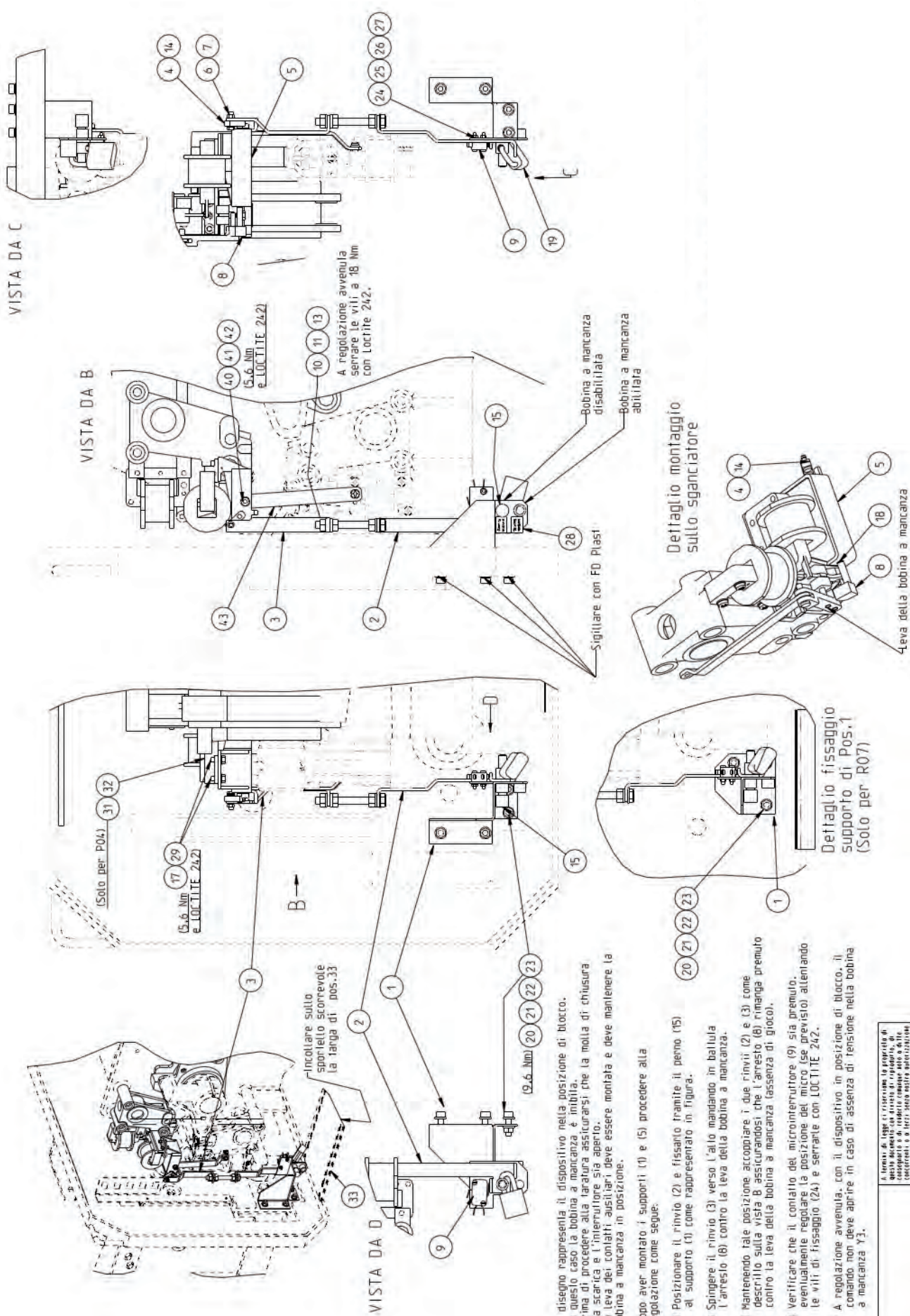
With the pin 15 in the lower hole the BLOCK 8 is not against the auxiliary catch: OPEN operation is possible. The transmission 2, 3 can be locked by a padlock.



## BLK 82 (Drawing 2GJA200104)





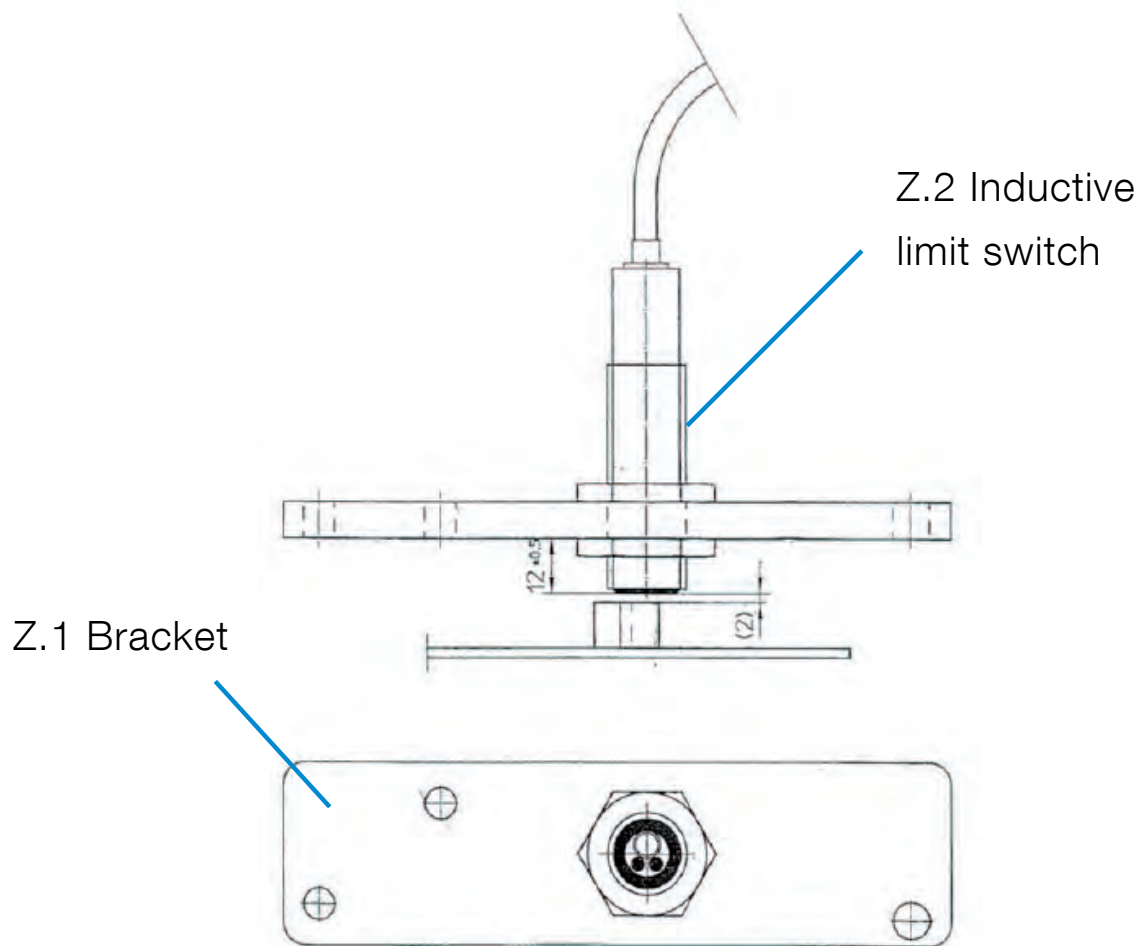


## 8. Alternative Device

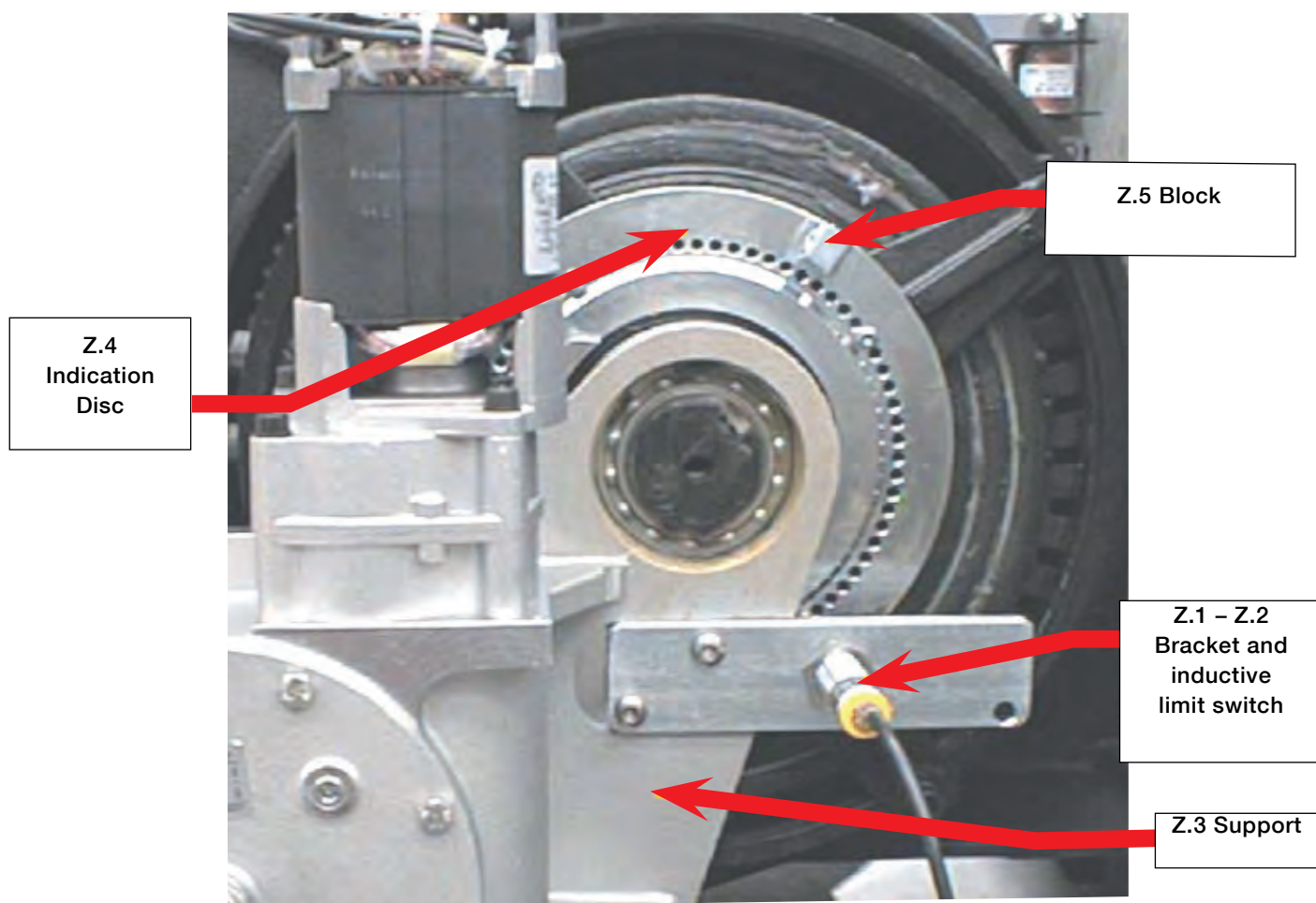
### 8.1 Inductive limit switch

An alternative solution to the mechanical limit switch (fig.C) is the inductive limit switch.

The device (Z.2) assembled on the support (Z.1) is an inductive position sensor that opens an electrical Contact in sensor with the closing spring charging circuit when a metal block reaches the position in that of the sensor. The closing spring with the above reported system is charged sin order to grant the CB operation and to prevent damage due to the overcharging.







## 9. Appendix A

### Grease “G”

Low-temperature grease for all type of bearings, gearing and worm gears and valves in air-blast circuit breakers. Also used for greasing sealing rings and crevice corrosion protection on breakers. Type HPL

### Grease “L”

Low temperature grease, especially suitable for lubricating precision components, such as latch mechanism operating in very cold environment.

### Grease “M”

Low temperature grease for long term and permanent lubrication of worm gears, and spur gears and other machine elements. Counteracts wear and corrosion.

SUPPLIER	GREASE “G”	GREASE “L”	GREASE “M”
<b>ABB art. N.</b>	1171 4014-407	1171 4016-606	1171 4016-612
<b>ABB spare part N.</b>	5316 318-A	5316 381-H	5316 381-J
<b>ASEOL AG</b>	-	ASEOL SYLITEA 4-018	-
<b>Klüber</b>			Isoflex Topas NB 52
<b>GULF</b>	718EP Synthetic grease	-	-
<b>MOBIL</b>	Mobil grease 28	-	-
<b>SHELL</b>	Aero Shell Grease 223	-	-

## Notes

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Doc. 2GJA700296

Rev. D 01/2013 [LM]

Title:

Bushing SF6/air 145-170 kV



# BUSHING SF<sub>6</sub>/AIR

## Pass M0 145 - 170 kV

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1.2 Technical Data	3
2. Erection and Commissioning Notes	4
3. Extraordinary Maintenance	4

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Table 1 – Extraordinary Maintenance	4
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# 1. General Description

**Overhead lines and Bus Bars are connected to the module by the air bushings.** The main insulation is obtained by the means of compressed SF6 gas.

The insulator consists of an epoxy impregnated fiberglass tube with silicon rubbersheds. The metal flanges are heat shrunk and glued onto the tube making an extremely strong and gastight joint.

The silicon rubber sheds are cast onto the tube and chemically bonded to it, thus allowing no moisture or contamination infiltration. The silicon rubber sheds are hydrophobic and ensure a very good performance with rain and pollution.

The main features are:

- High safety level (since they are explosion resistant);
- Low weight: 1/3 - 1/4 lighter than the porcelain ones
- Excellent pollution and rain performance;
- Resistant to sandstorm;
- Salty, tropical and polluted areas condition resistant;
- Internal Isolation completely in SF6 gas
- Maintenance free.

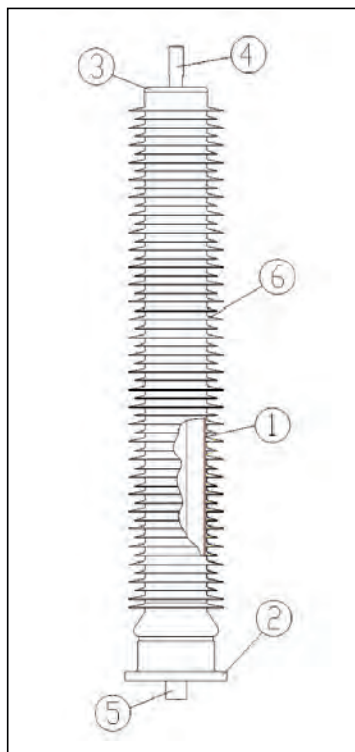


figure 1. Bushing's Section

## 1.2 Technical Data

### Bushings

- **Type** .....composite insulator
- **Rated Voltage** .....145 kV / 170 kV
- **Arching Distance**.....1304mm/1633 mm
- **Creepage Distance**.....4670mm/5462 mm
- **Max permissible static mechanical force:** according to the normative IEC 60137

#### Legend:

- 1) Reinforced cylinder made of glass, aramid and polyester endless fibers
- 2) Base Flange
- 3) Lid
- 4) Terminal
- 5) Primary Bus Bar
- 6) Silicone Rubber

## 2. Erection and Commissioning Notes

**Silicon bushing must be protected, during transport, by means of 0,15 mm thick polyethylene bags.** The bottom part must be sealed with clamp and adhesive tape resistant to saline atmospheres and high temperatures.



**WARNING:** Never use any sharp tools during unpacking to avoid damages on bushings

**Cleaning operations must be performed wiping the bushing with a cotton cloth soaked in a detergent.** Before starting a qualification test, it is mandatory to wait for a recovery time of at least 24 hours after cleaning.

These operations must also be performed in the case the annual inspection (refer to the document entitled “Preventive Maintenance”) detects signs of contamination on the bushing.

## Notes

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### 3. Extraordinary Maintenance

**Silicon bushings can only be touched with clean protective gloves (plastic or rubber).** For bushings which have been contaminated during transport or handling (greasy fingerprints or sooty gas exhaust, etc.) cleaning must be performed with different cleaning agents as described in the following table 1:

<b>Contamination Level</b>	Cleaning Agent
<b>Slight contamination</b>	5% watery solution of detergent
<b>Medium Contamination</b>	Aliphatic hydrocarbons such as "Rivolta M.T.X. 100)"
<b>Heavy Contamination</b>	Acetone or trichloroethylene

Table 1. Extraordinary Maintenance

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# SPARE PARTS

## Indice

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## Content of tables

Tab. 1	Set of spare parts	4
Tab. 2	Special tools	4

## 1. Set of spare parts for operation (not included in the supply) (otherwise confirmed)

Item	Description	Unit
1	Drive mechanism (BLK 222 or/and 82) for circuit breaker	1
2	Drive mechanism (BES7) for disconnect/earthing switch	1
3	Drive mechanism (BES6) for disconnect FES (if present)	1
4	Opening coil	1
5	Closing coil	1
6	Rupture disc for PASS	1
7	Rupture disc for VT (if present)	1
8	Set of heaters (2 for each type)	1
9	Set of relays (1 for each type)	1
10	Set of O-Rings (2 for each type)	1
11	Set of terminal blocks (3 for each type)	1

tab. 1

## 2. Special tools, appliances and SF<sub>6</sub> Gas Handling Equipment

The tools, appliances and SF<sub>6</sub> gas equipment necessary for assembly, operation and maintenance not included in the supply.

Item	Description	Unit
1	Circuit breaker (Hand – Crack) (supplied)	1
2	Set of keys for overhauling and maintenance	1
3	SF <sub>6</sub> bottle (kg 43)	1
4	Bottle carrying trolley	1
5	Empty bottle	1
6	Box containing SF <sub>6</sub> control and refill unit	1
7	Pressure gauge control	1
8	Complete piping for electronic hygrometer	1
9	Electrolytic hygrometer	1
10	SF <sub>6</sub> gas leak detector	1
11	DILO SF <sub>6</sub> filtering and recovering service wagon (option)	1

tab. 2

## 3. Logistic

The large number of operation and/or maintenance carried out on the PASS equipment requires that the operator makes use of all material, specified by the manufacturer, in these operating instructions.

### 3.1 Information for ordering

- The material mentioned in the tables can be supplied at any time. The following information is required so
- that the order can be understood and carried out quickly:
- allocation of equipment installation;
- order confirmation and serial number, according to the installation plate;
- identification number of these operating instructions;
- quantity, allocation and order number from the following tables, in this chapter.

## 4. Auxiliary Material

### 4.1 SF<sub>6</sub> Insulating Gas

Quantity	Allocation	Application	Order number
1	SF <sub>6</sub> insulating gas		Available commercially

### 4.2 Cleaning material

Quantity	Allocation	Application	Order number
1	Clean rags, without threads		Available commercially
1	Sand Paper		Available commercially
1	Scraper		Available commercially
1	Metal brush		Available commercially

### 4.3 Cleaning Agents

Quantity	Allocation	Application	Order number
1	Ethyl alcohol		Available commercially
1	Volatile agents		Available commercially

### 4.4 Greases and oils

Quantity	Allocation	Application	Order number
1	Grease: RHODIA Patè 4	Seals	Available commercially
1	Grease: ASEOL utea 806/12	Main contacts	Available commercially
1	Grease: ASEOL NLGI1 - 1730	BLK closure spring BLK releases	Available commercially
1	Grease: AEROSHELL 22	BLK kinetics	Available commercially

### 4.5 Adhesives

Quantity	Allocation	Application	Order number
1	FD Plast		UA500267P01
1	Silicone		Available commercially

## 5. Tools and equipment

### 5.1 Standard tools

Quantity	Allocation	Application	Order number
1	Installer tools		Available commercially

### 5.2 Special tools

Quantity	Allocation	Application	Order number
1	Crank for BLK	Charging spring of BLK	
1	Tool for turning main shaft	C.B.	
1	Complete crank	Drive BES7	
1	Crank	Drive BES6	

### 5.3 Equipment

Quantity	Allocation	Application	Order number
1	SF <sub>6</sub> control and filling kit		UA14631R06

Notes

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# LOCAL CONTROL CUBICLE - LCC (TYPICAL)



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1.2 The wiring area	page 8
1.3 Control Cable	page 8
2. ERECTION & COMMISSIONING NOTES	page 9
3. OPERATION	page 9
4. MAINTENANCE	page 9
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Fig. 2 Locking	page 4
Fig. 3 Wiring/terminal block area	page 4
Fig. 4 Hinged Command Panel	page 5
Fig. 5 Removable Metallic Plate	page 5
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Fig. 7 Three Position Selector Switch	page 7
Fig. 8 LV devices (Relays)	page 8
Fig. 9 Space heaters	page 8
Fig. 10 Multipolar plugs	page 8

# 1. General Description

The Local Control Cubicle is a metallic casing hosting all the auxiliary electrical units required for local command input, and signaling purpose of the primary equipment.



NOTE: This document provides general information which does not take into consideration specific project requirement. ABB ADDA reserves the right for changes in project requirement without any notice.



Fig. 1 LCC

Depending on the project requirement the cabinet may be made either by hot deep galvanized steel (painted or not) or stainless steel. The Local Control Cubicle is generally fixed directly on the support structure of the primary equipment but different solutions can be supplied depending on the specific project requirements.

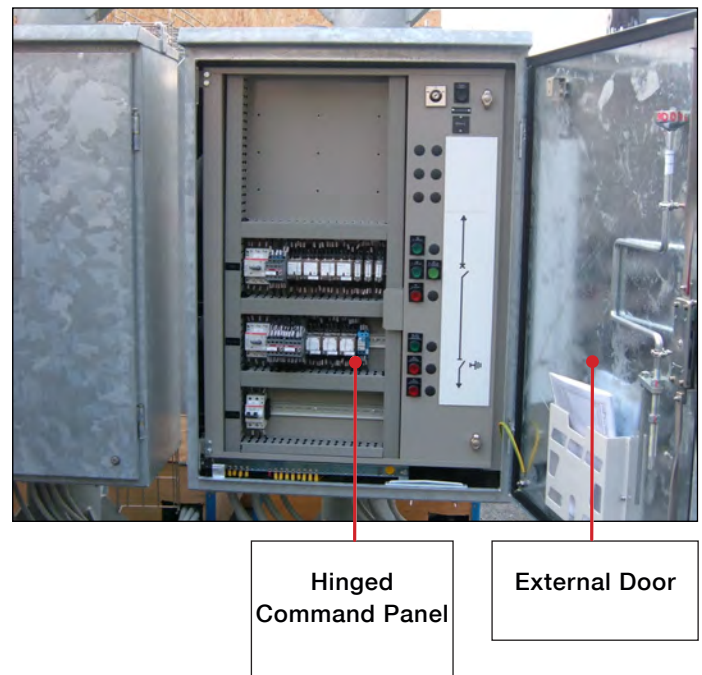
The cabinet is designed with all necessary elements and manufactured with all suitable procedures to provide the requested Protection Degree (IP protection Degree) and suitable internal condition for the proper operation of all the equipment. The above conditions are granted with the cubicle in vertical position fixed on its support, with the door closed and the space heater fed. The cubicle is fitted with an external door which can be locked by means of a key and fixed in open position with mechanical arm.

By opening the door the hinged command panel is accessible where all the control and signaling equipment are located. By opening the panel it is possible to access the wiring/terminal block area with all the circuitries laid in suitable cable trays and wired to relevant terminal block.

**Fig. 2 Locking**



**Fig.3 Hinged command panel**



Hinged  
Command Panel

External Door

Area di cablaggio/ morsettiera

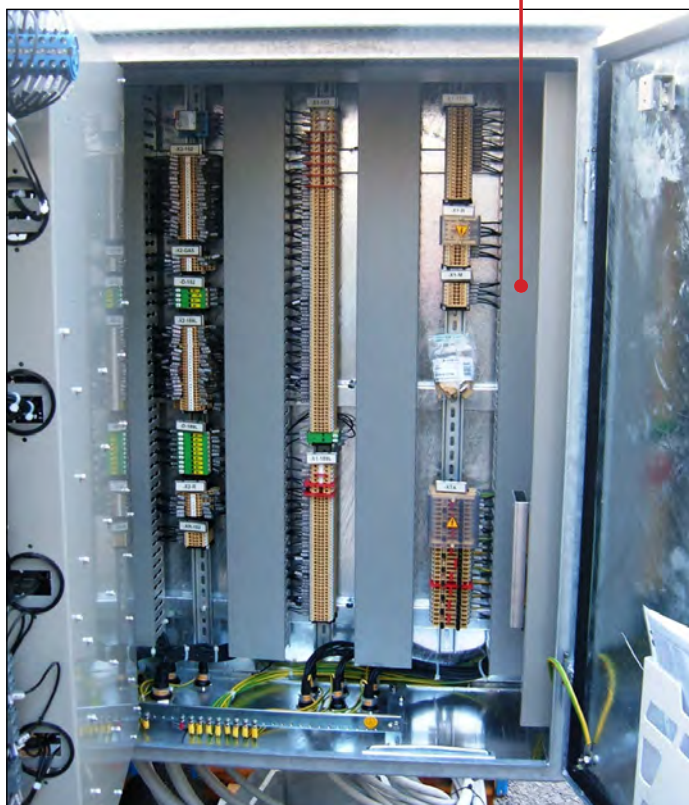


Fig. 4 Wiring/terminal block area



**WARNING:** Both the command panel and external door cannot withstand mechanical overload. Do not lean against the LCC and always lock the doors with suitable mechanical arms once opened. Always close the doors once the personnel are leaving the equipment.

At the bottom of the LCC is equipped with a removable metallic plate for the entrance of the substation cable.

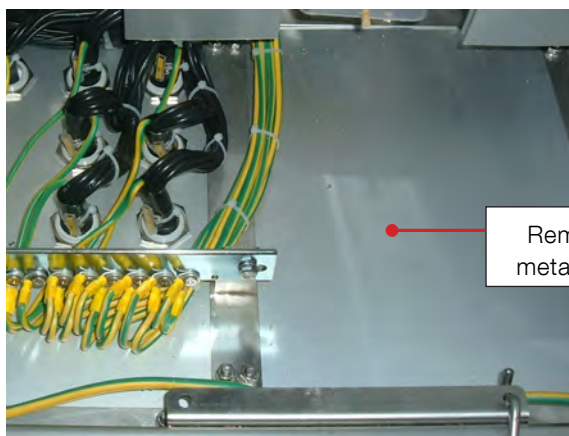


Fig. 5 Removable metallic plate

Additional feature like an internal light switched on by a door switch and a power socket for AC use could be present.



Fig. 6 Internal light

## 1.1. The control panel



**WARNING:** Please always refer to specific schematic drawing for the working and interlocking principle of the equipment. Not fulfill the working and interlocking principle arranged could cause serious damages to the equipment and to the system connected.

The command panel is usually fitted with the following equipment:

**-Three Position Selector Switch:** it allows the following types of operation:

- Remote: the Substation Level. The Equipment can be operated by remote control room and the local operations are excluded.
- Local: the Bay Level. The Equipment can be operated directly from the Local Control Cubicle and the remote operation are generally excluded (protection trip command might be present anyhow).
- Manual: the Service Level. The equipment cannot be operated by means of electrical input but only through manual operation.





Fig. 7 Three Position Selector Switch

- **Control switches:** the control of each primary equipment (circuit breaker, disconnector,...) is performed by means of push buttons or equivalent actuators.
- **MCB's:** Magneto-thermic devices protecting the auxiliary circuits are present and can be switched ON/OFF from the command panel.
- **CB counter:** an electromechanical device showing the number of operation performed by the Circuit Breaker.
- **Signalling devices:** the status of each primary switch of the equipment is shown in the local control cubicle by means of lamps, led-diode or electromechanical indicator depending on the project requirements. Generally the Signaling circuit is fitted with test –lamp application and it is switched off with the three positions selector switch in Remote/Manual positions.
- **A mimic plate** showing the reference to each primary equipment is placed on the command panel.

## 1.2. The wiring area

The wiring area is usually fitted with the following low voltage equipment: Relays, Power Converter, Cable trays, Terminal Block, Short Circuit Terminal Block (for CT circuit), Space heaters, and other devices and electrical equipments according to specific requests.



Fig. 8 Dispositivi BT (relè)



Fig. 9 Resistenze anticondensa

All low voltage auxiliary devices and wirings are performing the logic of operation and interlock designed for the primary High Voltage equipment and represented in the project schematics. Standard functions are:

- Circuit Breaker: closing Circuit , two opening Circuits, trip circuit, Anti-pumping function, interlock with SF6 and other equipment
- Disconnecter/ Earthing Switches: Opening and Closing Circuit, Interlock with other components.
- SF6: first level alarm (warning), second level alarm with the possibility to select the trip of the Circuit Breaker or the CB electrical lock, interlock with other equipment.



**Note: the auxiliaries contacts of each primary equipment (circuit breaker, disconnecter, earthing switch, density device, ..... ) to be used for interlocking, signaling, warning or alarm purpose are directly wired in the terminal block. The number of auxiliary contacts available for remote use depends on the specific project requirements and it is shown on the relevant project schematics drawing.**

## 1.3. Control Cable

All control cables of the equipment (Circuit Breaker Drive, Disconnecter Drive, Density Switch, CT's....) are wired into the LCC in suitable terminal blocks or directly on LV components. The control cables exit the LCC through cable glands and are connected on the other side to multi-polar Plugs. These Plugs will be easily connected to relevant Sockets of drives and density switches.

All Instrument Transformers (CT's, VT's) have to be connected in relevant secondary terminal box by means of ring terminals. The remote control cable (out of the scope supply) will enter the cubicle from the bottom through the section of the removable plate and will be wired directly on the terminal block.

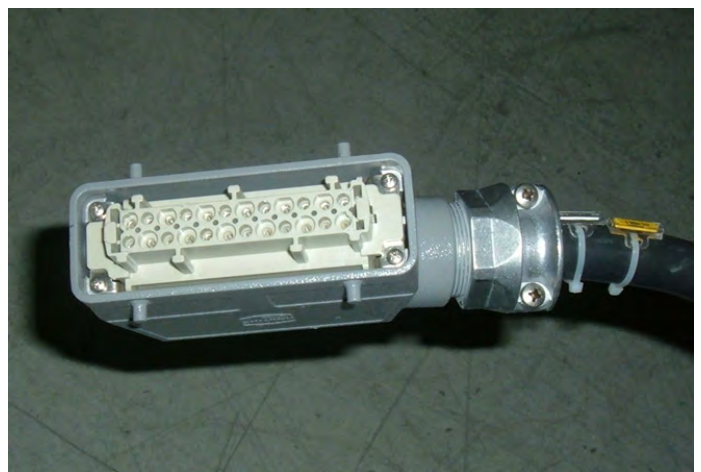


Fig. 10 Multipolar Plugs

## 2. Erection and commissioning notes

Before proceeding with any electrical operation please verify the correct connection of the earthing of the cubicle with its support structure and then with the earth grid of the substation. All activities involving the inside of the cubicle like wiring of the cables during Erection and Commissioning or any service/maintenance activity shall be avoided during windy or stormy days in order to prevent dust or water to enter the cubicle itself. Before proceeding with any electrical operation please verify the ALL auxiliary circuits are powered. The Power supply brought to partial circuitry might cause dangerous override of internal interlock.



IN CASE THE CURRENT TRANSFORMER CIRCUIT IS NOT CONNECTED PLEASE CHECK THAT RELEVANT TERMINAL BLOCKS ARE SHORT CIRCUITED IN ORDER TO AVOID HAZARDOUS VOLTAGE FOR PERSONNEL.

## 3. Operation

The operation of the equipment through the Local Control Cubicle shall be performed by skilled people knowing the working and interlock principle of the equipment in each situation. Don't leave the door open without the operator present.

## 4. Maintenance

All maintenance operation shall be performed by skilled and authorized people.

## 5. Warning



WARNING: Dangerous Voltage might be present in the wiring zone of the cubicle



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# **STORAGE INSTRUCTIONS BEFORE ASSEMBLY ON SITE**

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1.1	Scope of this manual	3
2.	STORAGE	3
2.1	Controls upon receiving the goods	3
2.2	General information on packaging and transportation	3
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3.1	Particular storage conditions	4
4.	START-UP AFTER STORAGE	4
5.	START-UP AFTER A LONG STORAGE PERIOD	4

# 1. General Description

Storing an integrated compact module (MCI) or GIS calls for special precautions in accordance with the following requirements.



**WARNING: carefully follow what is described in this manual!  
Non compliance with the storage and control instructions can limit or make the warranty conditions void.**

## 1.1. Scope of this manual

This document describes the correct method for the preservation of multifunctional hybrid equipment.

# 2. Storage

## 2.1 Controls upon receiving the goods

Every delivery must be checked upon arrival to verify:

- that the shipment is complete and correct (check delivery documents);
- the conditions of the packaging and any breaks or deformations;
- whether the external part of the packaging shows:
- Signs of crashes
- Signs of humidity

Any irregularity found must be reported to the: Shipment Office ABB PPD U.O. Adda.

At the end of the controls the person in charge must fill out and sign the relevant control list.

## 2.2 General information on packaging and transportation

Taking into account the limitations set by transportation and the on-site assembly possibilities, all possible sub-units are assembled and tested in the factory by the manufacturer.

The detailed list of components, with relating quantity, is available with the shipment documents.

The shipment units can be shipped with the following modalities:

- with gas SF<sub>6</sub> (pressure 0.02 – 0.03 MPa at 20°C) for the two units that do not foresee the opening of the gas compartment on site;
- with nitrogen (pressure 0.02 – 0.03 MPa at 20°C) for the units that foresee on-site assembly (preparation of compartments).

All the parts that form the module are packaged in order to avoid mechanical stress, to be protected against atmospherics (rain, humidity, dust) and support the loading and unloading operations and handling in the assembly site. The larger units, made up by the module, is sent ready to be stored; we suggest packaging the material in a covered place, the storage period is thus unlimited. The cabinet is usually packaged on pallets or wooden crates. The items in detail such as nuts, bolts, gaskets, contacts, ducts, gas density gauges, special equipment, are packaged in wooden boxes. These boxes must be kept in closed environments. By following these instructions it is possible to store the goods for a long periods of time.

## 2.3. Storage

### Storage indoors

The covered storage warehouse has the following features:

- Strong and even floor;
- Humidity lower than 70%;
- temperature 20°C ± 10°C.

### Storage outdoors

If the material is stored outdoors, the shipment units must be placed on a dry surface, solid and well-drained. The equipment must be protected against atmospherics with polyethylene sheets.

The anti-condensate circuit of the control and command cabinet must be powered using a proper power source. If the anti-condensate circuit was designed with resistors in series (commands and control cabinet) it is necessary to prepare a proper ohm circuit.

Crates and boxes containing bolts and screws, gaskets, isolating discs, pre-set break discs, gas density gauges, electric or electronic parts must be kept in closed environments (preferably in a dedicated cabinet).

Furthermore:

- control the conditions of the equipment, of the packaging and protection sheets every three months;
- control the pressure of the compartments shipped with SF<sub>6</sub> or nitrogen every 3 months directly on the gas density gauges.

## 3. Storage of spare parts

The spare parts are generally placed in wooden boxes and no other packaging is needed. For indoor or outdoor storage refer to the instructions above.

### 3.1 Particular storage conditions

The spare parts for emergency interventions or for maintenance must be stored according to different criteria, as follows:

- a) Spare parts that do not have to be exposed to humidity

The components must be kept in a well-aired out area.

- b) Spare parts and products that can easily deteriorate or with an expiration date, such as rubber parts, lubricants, adhesives.

- c) **Rubber parts**

Relative humidity must not exceed 65% from 15°C to 25°C, for a long period.

To prevent deformation, do not pile more than 3 packages of gaskets.

To avoid damages caused by exposure to light, oxygen and ozone, the rubber pieces must be placed in black plastic bags and sealed.

Storage at these conditions assures storage, as indicated on the packaging.

### Lubricants and adhesives

Proper storage conditions are indicated on the label or instructions booklet.

- d) Flammable products, such as detergents and solvents, grease, oil, paint and adhesives.

Storage conditions depend on the environment and national regulations.

## 4. Start-Up after storage

Transportation covers must be removed shortly before starting assembly operations, so that the equipment is exposed as little as possible to air and it's avoided the exposure of isolating and metal surfaces to humidity.

During assembly, SF6 compartments must be conditioned before being finally filled with gas SF6 at rated pressure. Follow specific instructions.

## 5. Start-up after a long storage period

If storage lasts more than 5 years, besides normal operations a specific check must be performed on switches, disconnecting switch, SF6 seal, feedthrough (if foreseen), to make sure that the conditions of the equipment are suitable for safe installation.

## NOTES

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**Circuit Breaker in SF<sub>6</sub>  
for bays  
up to 170 kV  
type Pass M0**

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------------------------------------	---

# 1. Introduction

The breaking chamber of PASS M0 is self-blast or auto puffer type and it is realized by three single metal enclosed poles. The module is insulated by means of sulphur hexafluoride SF<sub>6</sub>. This chamber is an high quality component and it's a long lasting product in service, even in case of the hardest conditions.

## 2. Main characteristics and advantages compared to hv conventional equipment

- Weights and dimensions reduction;
- SF<sub>6</sub> Reduction inside the enclosures;
- Decreasing of the main maintenance operations;
- Simplicity in the operations of maintenance.

## 3. Description of the equipment

The circuit breaker is realized by three separated poles with breaking chamber located in horizontal or vertical position. Type BLK drives can move each of the three pole separately (BLK82) or the three poles simultaneously (BLK222).

The position of the circuit breaker can be horizontal or vertical according to the bay layout typology.

On the circuit breaker outputs/inputs it is possible to install conventional multi-cores and multi-ratio current transformers.

The circuit breaker enclosure is connected to the different components by means of bolted flanges.

### 3.1 Accessories

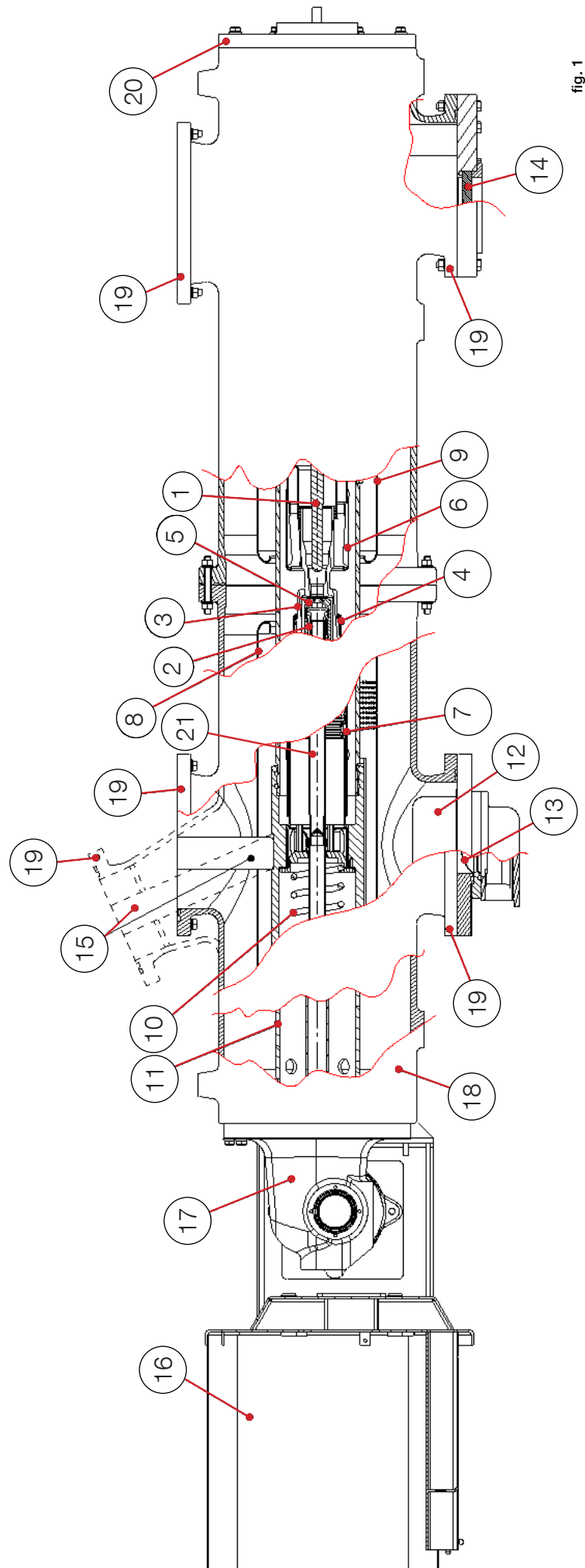
The circuit breaker PASS M0 is equipped with the following accessories (assembled on each pole):

- Gas valve DN8, for filling, top up and control;
- Density monitor with auxiliary contacts and manometric indication
- Rupture disk;

## 3.2 Composition (figura 1)

The circuit breaker is basically composed of:

1. Arcing contact - Contact tip
2. Mobile Contact
3. Nozzle
4. Contact Cylinder
5. Arcing fingers - Switching fingers
6. Fixed Contact
7. Contact springs
8. Lower Shield
9. Upper Shield
10. Opening Spring
11. Supporting insulating cylinder
12. Molecular Sieves
13. Rupture Disc
14. Inspection window
15. Terminal stud
16. Circuit breaker command type BLK
17. Carter
18. Circuit breaker enclosure
19. Flange
20. Cover
21. Pull rod



## 4. Breaking chamber

## 5. Maintenance

### 4.1 General Information

The adopted breaking chamber is self-blast type or auto-puffer type. The energy for closing operation is stored in the spiral spring of the BLK drive. The opening operation springs are located inside every pole, they are charged when breaking chamber positions is closed and therefore always ready to give energy for opening.

In normal operating conditions it is not request any maintenance. For further informations please refer to the relevant "Preventive Maintenance" manual, doc. 2GJA700293.

### 4.2 Operation of the auto-puffer breaking chamber

In order to break the switching arc, the PASS M0 circuit breaker takes advantage of the "self-blast" or auto-puffer principle. The main difference between Puffer type and auto-puffer type is that the first system takes 50% of the energy from the springs and 50 % from the switching arc.

### 4.3 Opening

After the Opening coil device operation (located inside the BLK), the mobile contact(2) move, taking away the contact cylinder (4).

Therefore the current has to flow in the contact tip (1) and in the switching fingers (5).

Then the switching fingers (5) leave the contact tip (1), in order to put the arc between the contact tip and the switching fingers (5).

At the same time a blow of SF<sub>6</sub> gas is created directly on the electric arc to be broken.

### 4.4 Closing

After the Closing coil device operation (located inside the BLK), the mobile contact (2) move, getting the switching fingers (5) close to the contact tip(1); then, the switching fingers bear the created arc until its termination that happens in the moment of the contact. Afterwards, the contact cylinder (4) enters in the fixed contact(6) making the all current flow.

## Notes

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Doc. 2GJA708356  
Rev. A 01/2013 [LM]  
Title: Circuit Breaker in SF<sub>6</sub> Pass M0 145-170 kV  
Rotating Chamber - SBB

# **Circuit breaker in SF<sub>6</sub> Pass M0 145-170 kV Rotating Chamber - SBB**



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# 1. Introduction

The breaking chamber of PASS M0 is self-blast or auto puffer type and it is realized by three single metal enclosed poles. The module is insulated by means sulphur hexafluoride SF6. This chamber is an high quality component. This component has both long duration in service and applications in the most hard conditions.

## 2. Main characteristic and advantages compared to HV Conventional Equipment

- reduction of the weights and the dimensions;
- reduction of SF6 inside the enclosures;
- reduction of the main maintenances;
- easy maintenance.

# 3. Description of the equipment

The circuit breaker is realized by three separate poles with breaking chamber located in horizontal position. The drive type BLK can move each pole separately (SPO - BLK82) or all three poles (TPO - BLK222). The circuit breaker can also be installed in vertical position.

On the circuit breaker bushing is possible to install conventional ring type current transformers multi-cores and multi-ratios.

The circuit breaker enclosure is connected to other elements by means screwed flanges.

## 3.1. Accessories

The circuit breaker PASS M0 is equipped with the following accessories (assembled on the module):

- one gas valve DN8, for filling, topping up and control;
- one density monitor with auxiliary contacts and pressure indication – upon request one density for each pole;
- one rupture disk for each pole;

## 3.2. Breaking Chamber

### 3.2.1. General Description

The energy for closing operation is stored in the spring of the BLK drive. The opening operation springs are located inside every pole, they are charged when breaking chamber positions is closed and therefore always ready to give energy for opening.

### 3.2.2 Description of disconnecter (Fig. 1, 2, 3, 4)

The main characteristic of the breaking chamber is the rotation on its own axis. This rotation allows the closing/opening of the fixed and mobile contacts of the disconnectors according to the following explanation.

The initial condition of module is the following: the circuit breaker, disconnector bushing 1, bushing 2 are closed (see figure 1). Starting from the above mentioned condition and after having opened the circuit breaker, it is allowed the rotation.

When the circuit breaker is open, it is possible to proceed with a rotation clockwise ( $\alpha$ ) of the circuit breaker which

permits to have all disconnectors (bushing 1 and bushing 2) open (see figure 2).

Again rotation clockwise ( $\beta$ ) of the circuit breaker allows the disconnector bushing 2 opening. On the other word the blade of the disconnector bushing 2 is disconnected from the fix contact (see figure 3).

Another rotation clockwise ( $\omega$ ) allows the closing of the disconnectors bushing 1 and Earth (see figure 4).

At this point, it is possible closing the circuit breaker to put on earth the bushing bushing 2 and so the line.

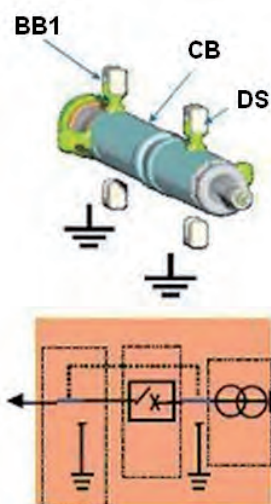


Fig. 1

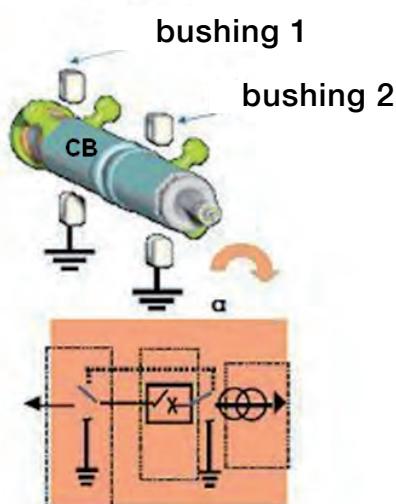


Fig. 2

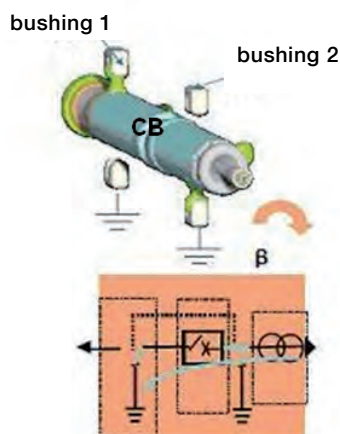


Fig. 3

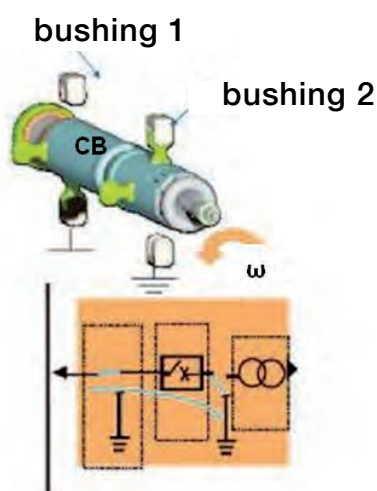
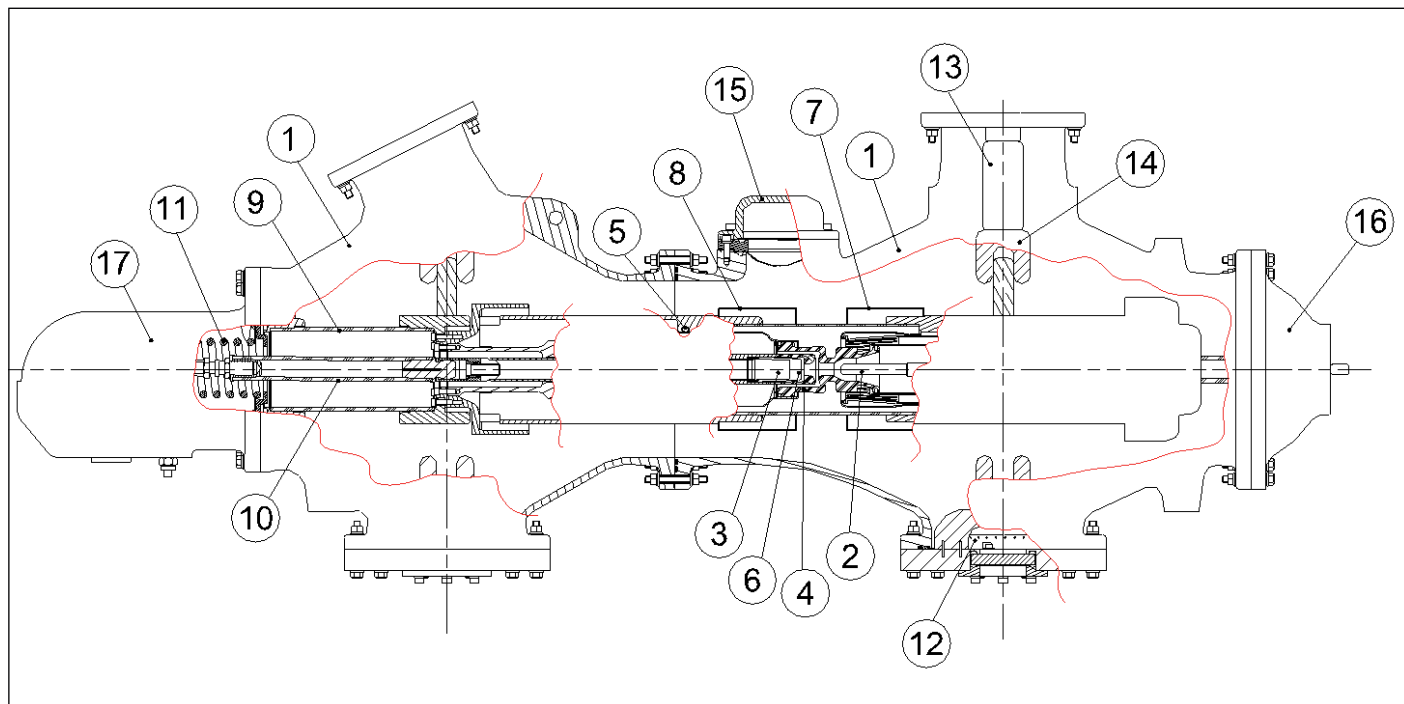


Fig. 4

Figura 5. Breaking Chamber



Legenda:

- |                                 |                     |
|---------------------------------|---------------------|
| 1. enclosure;                   | 10. pull rod;       |
| 2. circuit breaker;             | 11. opening spring; |
| 3. mobile contact;              | 12. dehydrators;    |
| 4. nozzle;                      | 13. busbar;         |
| 5. contact spring;              | 14. fixed contact;  |
| 6. arcing finger;               | 15. rupture disc;   |
| 7. upper shield;                | 16. cover;          |
| 8. lower shield;                | 17. carter;         |
| 9. support insulating cylinder; |                     |

## 4. Maintenance

In normal operation, maintenance is not requested. For more information see the manual of preventive maintenance.

## Notes

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Doc. 2GJA708357  
Rev. A 01/2013 [LM]  
Title: Circuit Breaker in SF6 Pass M0 -  
Rotating Chamber - DBB

# **CIRCUIT BREAKER in SF6 PASS M0 – ROTATING CHAMBER - DBB**

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# 1. Introduction

The breaking chamber of PASS M0 is self-blast or auto puffer type and it is realized by three single metal enclosed poles. The module is insulated by means sulphur hexafluoride SF6. This chamber is high quality component. This component has both long duration in service and applications in the most severe conditions.

## 2. Main Characteristics and advantages compared to hv conventional equipment

- reduction of the weights and the dimensions;
- reduction of SF6 inside the enclosures;
- reduction of the main maintenances;
- easy maintenance.

## 3. Description of the equipment

The circuit breaker is realized by three separate poles with breaking chamber located in horizontal position. The drive type BLK can move each pole separately (SPO - BLK82) or all three poles (TPO - BLK222). The circuit breaker can also be installed in vertical position.

On the circuit breaker bushing is possible to install conventional ring type current transformers multi-cores and multi-ratios.

The circuit breaker enclosure is connected to other elements by means screwed flanges.

### 3.1. Accessories

The circuit breaker PASS M0 is equipped with the following accessories (assembled on the module):

- one gas valve DN8, for filling, topping up and control;
- one density monitor with auxiliary contacts and pressure indication – upon request one density for each pole;
- one rupture disk for each pole;

### 3.2. Breaking Chamber

#### 3.2.1. General Description

The energy for closing operation is stored in the spring of the BLK drive. The opening operation springs are located inside every pole, they are charged when breaking chamber positions is closed and therefore always ready to give energy for opening.

### 3.2.2 Description of disconnecter (Fig. 1, 2, 3, 4 and 5)

The main characteristic of the breaking chamber is the rotation on own axis. This rotation allows the closing/opening of the fixed and mobile contacts of the disconnectors according to the following explanation.

The initial condition of module is the following: the circuit breaker, disconnector BB1, BB2 and DS are closed (see figure 1). Starting from the above mentioned condition and after having opened the circuit breaker, it is allowed the rotation. A rotation counter clockwise ( $\alpha$ ) of the circuit breaker allows the disconnector BB2 opening. On the other word the blade of the disconnector BB2 is disconnected from the fix contact (see figure 2).

Again with the circuit breaker open a rotation clockwise ( $\beta$ ) (see figure 3) permits the closing of the disconnectors DS and BB2. Thus, the closing of the circuit breaker makes possible to connect incoming line (bushing DS) and bus bar (BB2). Again when the

circuit breaker is open, it is possible to proceed with a rotation clockwise ( $\omega$ ) of the circuit breaker which permits to have all disconnectors (DS, BB1 and BB2) open (see figure 4). Keeping opened the circuit breaker, the rotation clockwise ( $\lambda$ ) allows the closing of the disconnectors DS and Earth (see figure 5). At this point, it is possible closing the circuit breaker to put on earth the bushing DS and so the line.

fig. 1

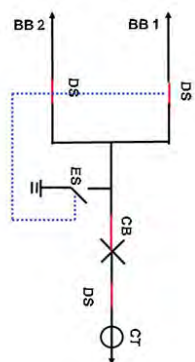
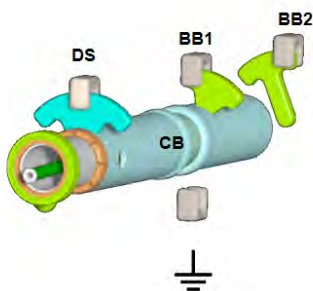


fig. 2

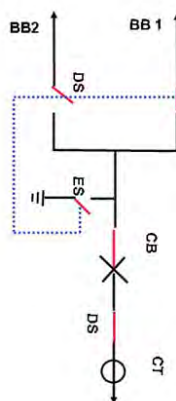
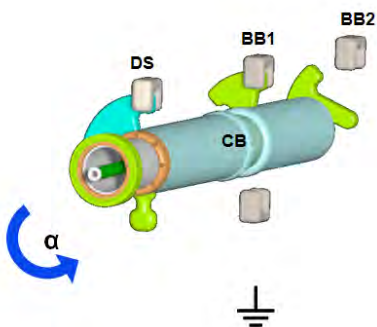


fig. 3

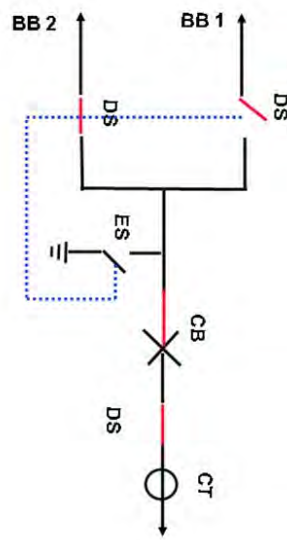
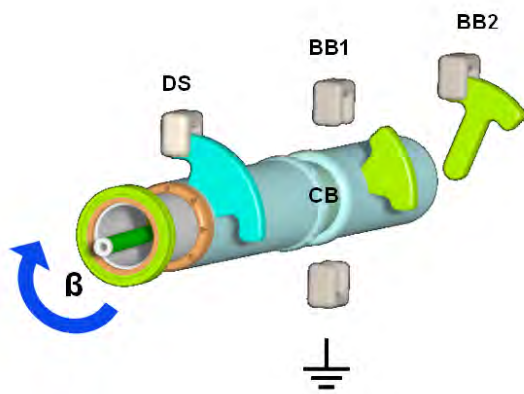


fig. 4

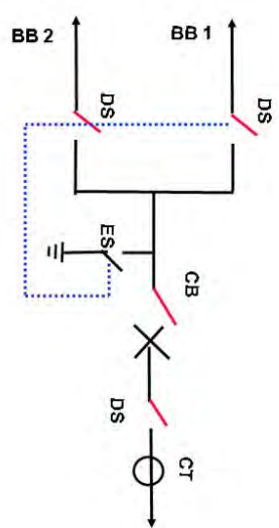
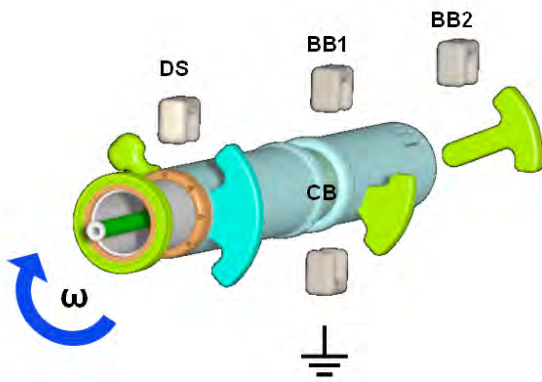


fig. 5

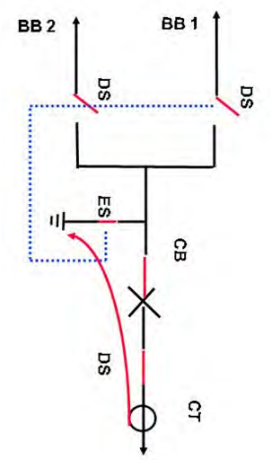
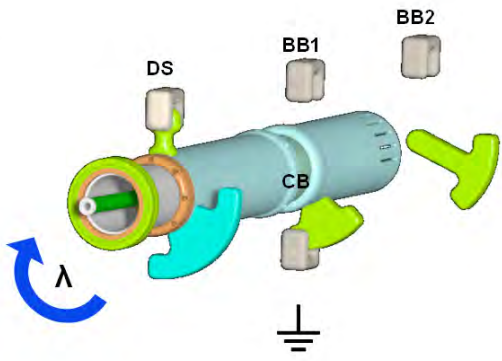


Figure 6 legend:

- 1. enclosure;
- 2. circuit breaker;
- 3. mobile contact;
- 4. nozzle;
- 5. contact finger;
- 6. arcing contact;
- 7. upper shield;
- 8. lower shield;
- 9. support insulating cylinder;
- 10. pull rod;
- 11. opening spring;
- 12. dehydrators;
- 13. busbar;
- 14. fixed contact;
- 15. rupture disc;
- 16. cover;
- 17. carter;
- 18. barrier insulator;

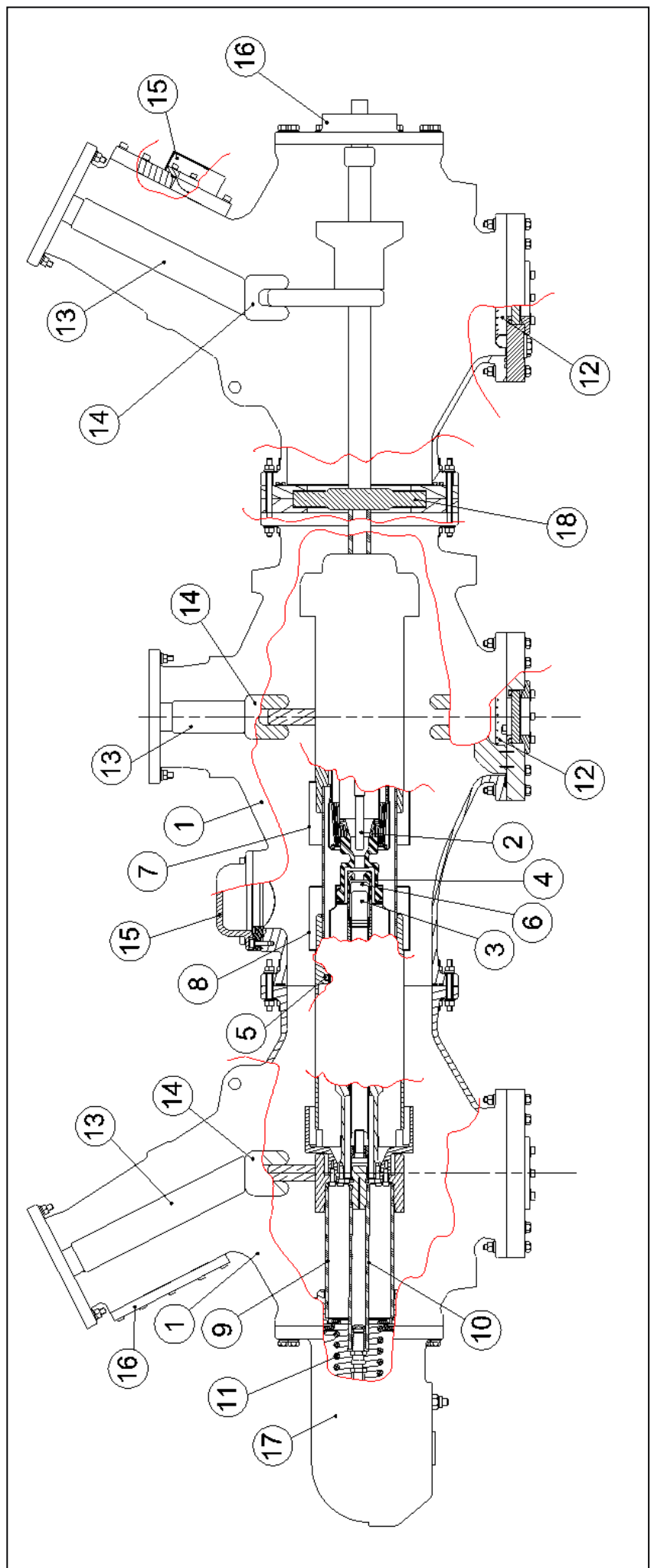


fig. 6 Camera di interruzione

## 4. Maintenance

In normal operation, maintenance is not requested. For more information see the manual of preventive maintenance.

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Doc. 2GJA700303

Rev. F 02/2013 [LM]

Title:

Current Transformer Type TAT



# CURRENT TRANSFORMER type TAT

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2. ASSEMBLY AND START-UP	5

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# 1. General

## 1.1. Main Components

GIS devices or hybrid devices such as PASS are fitted with a conventional ring current transformer. The problem of the measurement of very intense currents is solved indirectly by using proper current transformers. These devices have the following functions: transform according to a pre-set ratio and constant the current values of the circuit they are positioned in, to limit them to the most convenient values for the power supply of the various measurement and protection instruments. There must be a clear separation between the main or primary circuit and the measurement or secondary circuit. The use of amperometric transformers is also applied to the feeding of several auxiliary devices: adjustment, protection and control devices for high voltage electrical systems. The creation of a secondary voltage and current measurement circuit, adequately limited, allows a significant saving in the cost of power of the various measurement and control systems. The toroidal transformer does not have its own winding on operating voltage, because the function of the primary is directly performed by the conductor. There are several core combinations available for protection and measurement, according to the performance and the class requested by the project. For the real number of cores refer to the project's documentation.

The TAT is made up of a stainless steel metal enclosure containing the protection and/or measurement cores with the relevant secondary windings that are connected to the terminals of the secondary box. All the cores are immersed in an epoxy resin. The primary circuit is made up of the conductor rail inserted inside the enclosure where the TAT is positioned. Basically the toroid made up by the TA is separated from the gas compartment and completely external from the high voltage circuit. No primary connections are foreseen and a ratio change is possible only on the secondary terminal block.

## 1.2 Technical details

### Legend:

- |                                 |                         |
|---------------------------------|-------------------------|
| 1. Metallic enclosure           | 6. Technical data plate |
| 2. Cores and secondary windings | 7. Polarity plates      |
| 3. Epoxy resin                  | 8. Cable gland          |
| 4. Gasket                       | 9. Secondary terminals  |
| 5. Cover                        | 10. Diagram plate       |

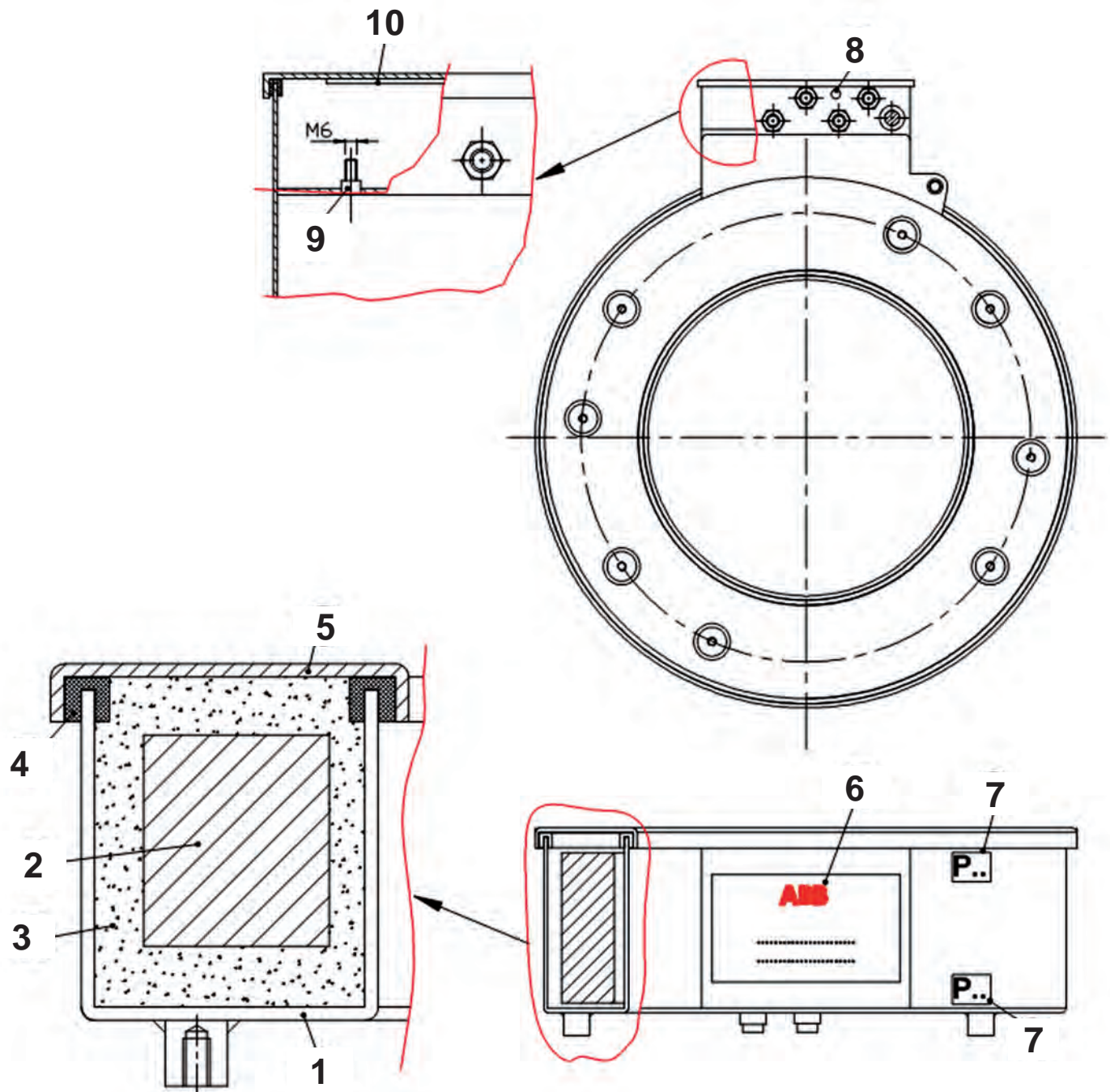


Figure 1 – Current transformer type TAT

## 1.3. Technical Data

The following current transformer data are just a reference.  
The actual data is contained in the documentation enclosed with the device.

### Current transformer data (just a reference)

Type	TAT
Measurement Class	0,2s/0,2/0,5/0,5s/1,0
Protection Class	5P-10P / 5-10-15-20-30
IP Code (IEC 60144)	IP 44-54
Ratio	300-600-1200/1-1-1 A
Cores	1÷5
Performance	10÷50 VA
Rated continuous current	1,2 In

## 2. Assembly and start-up

The level of protection specified is reached and guaranteed only if the current transformer is assembled and fixed to the device's support, with the cover of the secondary box accurately closed. The TA is shipped already assembled on the module. Therefore it does not require any specific assembly operations on site. The TA is fitted with all the secondary windings in short circuit and earthed. The short circuit connections must not be removed before the relating terminals are connected to the loads or other short circuit circuits. All maintenance operations are performed by specialized personnel.



**WARNING:** in the secondary current transformer outlets there may be dangerous voltages. The secondary circuits must not be left open without load!



**WARNING:** check carefully if the CT case don't touch the internal bushing flange because it is strictly mandatory to avoid any contact between CT case and internal metallic parts, see fig. 2

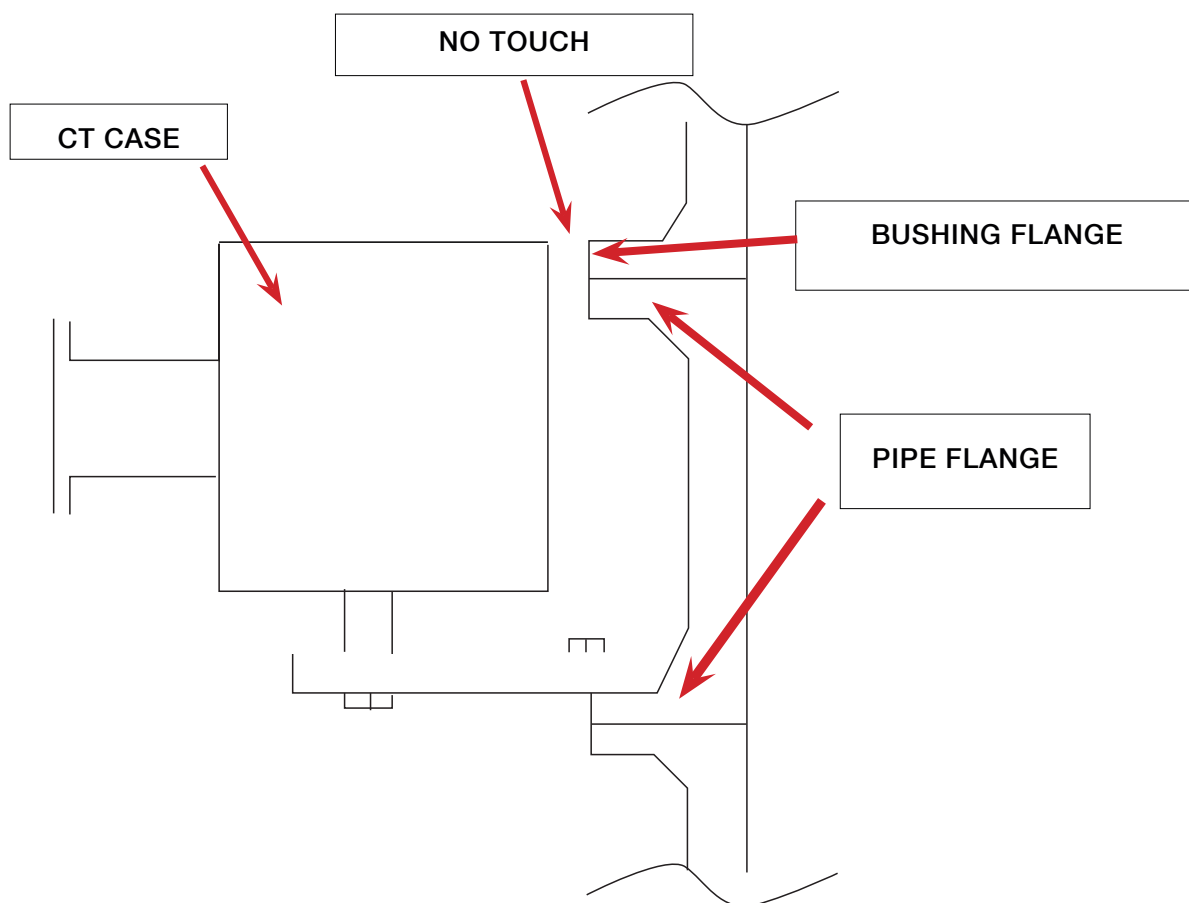


fig.2 CT Case position next to the bushing flange and the pipe flange

## Notes

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# Erection and commissioning (Typical)



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4.3	Assembling the main shipping unit	8
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# 1. General information

This manual has been written to explain the main operations to be performed to assembly the module.



## Note

all descriptions within this document are generic informations that do not take into consideration specific project requirement. Please refer to specific project schematics for the working and interlocking principle of the equipment

For your safety:

- Check that all the installation operations, commissioning and maintenance are performed by trained personnel
- Verify that during the installation, in-service and maintenance phases, all the normative prescriptions of law are respected, for the performing of the facilities according to the good technique and safety rules at work.
- Strictly observe the instructions within this manual



## Warning:

Verify that the personnel operating on the equipment has this manual and all the necessary informations for a correct operation available.

# 2. Shipping

The module is completely tested at the factory. The mechanical and dielectric tests are performed on the completely assembled module. The module is shipped with the circuit breaker open, its closing springs unloaded and the combined disconnecter closed on the earth side. The poles are already conditioned and filled with SF<sub>6</sub> gas at a pressure of 0.02-0.03 MPa rel. at 20°C.



## Note:

On request, provide special packaging.



## 3. Incoming Check

On the products arrival, check the entire module in detail, especially the density switches, the controls of the circuit breaker, the disconnect and the bushings. Verify that the equipment shows no signs of breakage or tampering. Make also sure that all the products described in the shipping bill are present in the scope of supply. If discrepancies are found, please inform our shipping office. The equipment is provided only with the accessories specified in the order and validated in the order confirmation sent by ABB.



### Warning:

verify before you perform any operation that the springs are unloaded and the device is in the open position.

## 4. Installation

### 4.1. Introduction

The following main operations must be performed to install this equipment:

- check the civil works (if it is to be assembled on plinths, or a platform, made of reinforced concrete);
- check the presence of gas at low pressure of 0.02-0.03 MPa rel. at 20°C by using the density monitor or by a slow pressure on the filling valve;
- check the layout, the secondary circuit drawings, all the necessary accessories;
- remove the packaging;
- position the terminal stud on the clean bushings;
- fix the vertical supports on the reinforced concrete plinths (if present) using the chemical or expansion plugs;
- position and assemble the main shipping unit;
- lay and connect up the L.V. cables;
- connect the earth cables;
- fill with SF<sub>6</sub> at rated pressure.

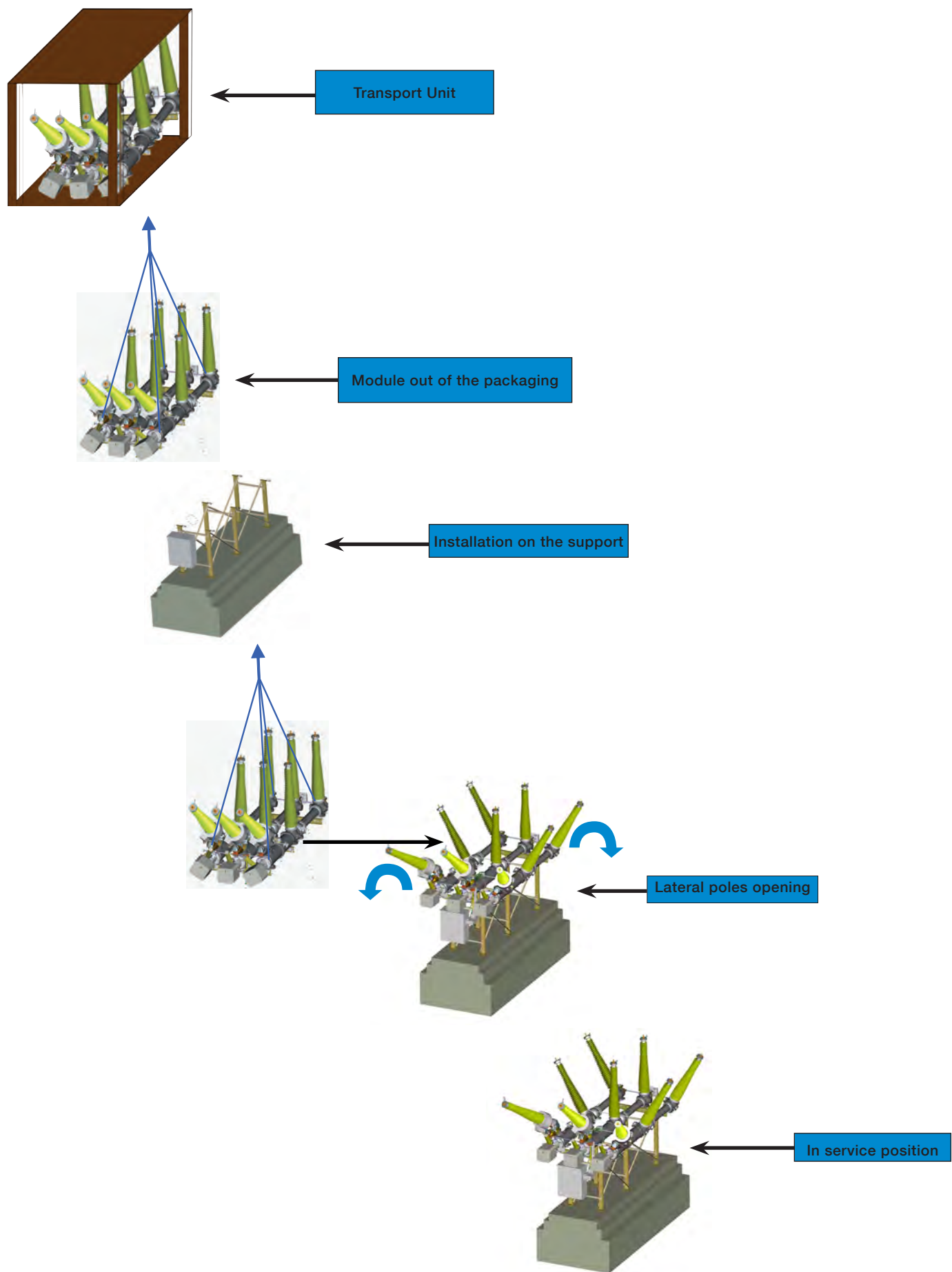


Figure 1 steps for the installation of the module



**Warning:** do not operate the circuit breaker at transport pressure. Only operate the circuit breaker when the pressure is at nominal value.

## 4.2. Fixing the vertical frame (fig. 2)

**Place the chemical anchor bolts (if supplied with the module) in the concrete platform and correct displacement quotes.**

(You can use the support structure itself as a jig to identify the fixing footprint, but keep care to remove the structure before drilling the concrete).

Proceed as follows:

**For the drilling (see the illustrations on fig. 2) follow the next steps:**

1. **a)** Rotary hammer drill: set the depth gauge to the correct drilling depth.
- b)** Diamond coring: mark the correct drilling depth on the height adjustment mechanism.
2. Clean the hole immediately before setting the anchor. Remove drilling dust and standing water from the base of the hole by blowing out well with at least 4 strokes of the blow – out pump, or using compressed air or an industrial vacuum cleaner. The anchor holes must be free of dust, water, ice, oil, bitumen, chemicals or any other foreign matter or contaminants.
3. Check that the hole is drilled to the correct depth before setting the anchor. Hole depth is correct when the anchor rod contacts the base of the hole and the setting depth mark coincides with the concrete surface.
4. Push the anchor capsule into the drilled hole.
5. Use the setting tool at a speed of 250 – 200 r.p.m. to drive the anchor rod into the hole, applying moderate pressure and with the hammering action switched on.

6. Switch off the rotary hammer drill immediately when the setting depth is reached. After setting, adhesive mortar must fill the annular gap completely, right up to the concrete surface. Prolonged rotary action may cause mortar to be forced out of the hole, resulting in reduced anchor loading capacity.

7. The working time “t rel” which depends on base material temperature, must be observed.

8. Do not manipulate or disturb the anchor until the curing time “t cure” has elapsed.

9. A load may be applied to the anchor only after the curing time “t cure” has elapsed.

10. The working time “t rel” and curing time “t cure” which depend on base material temperature, must be observed.

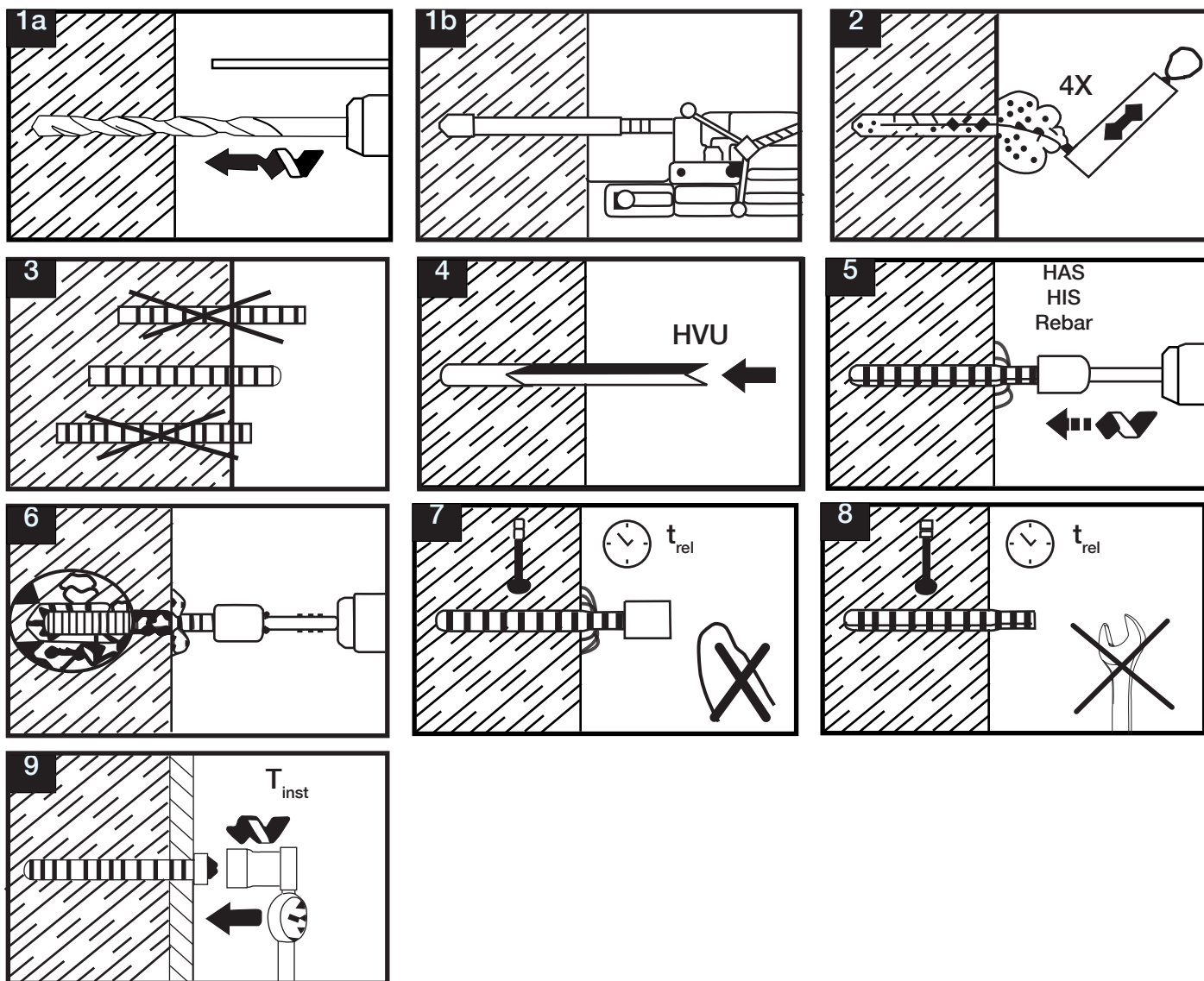


Fig. 2 Instructions for the anchor holes

Lift and position the supporting structure by using a crane and take care that no space is left between concrete of foundations and bottom plate of support structure.

°C	°F	t <sub>rel</sub>	t <sub>cure</sub>
Min. -5° ... 0°	Min. 23° ... 32°	60'	5h
0° ... 10°	32° ... 50°	30'	1h
10° ... 20°	50° ... 68°	20'	30'
20° ... max. 40°	68° ... max. 104°	8'	20'

### 4.3. Assembly of the main shipping unit

Lift the module with a crane checking that it is perfectly balanced before handling it: the weight of the module is indicated in the documentation relevant to the project.

**(Note: all the lifting accessories such as belts, shackles, belt-tighteners etc. are NOT included in the supply.)**

Move it close to the previously fixed support frame taking care to line up the holes of the main module beam with those of the support structure. Insert the M16 bolts and tight relevant nuts with torque 14 daNm. Unhook all the lifting accessories.

### 4.4. Rotation of the lateral poles (Fig. 2)

After fixing the module on the supports, the lateral poles have to be widened with the following procedure:



**WARNING: check that the Circuit Breaker is in the open position and the BLK drives springs are unloaded**

1) Temporary remove the disconnecter linkages from the external poles and keep them nearby for next re-assembling.

2) Unscrew and remove the bolts M16 (position 10 in the below figure n. 2).

3) Slightly loose the nut M16 (position 11 in the below figure n.2) in order to allow the pole rotation but without removing it.

4) By means of a spanner turn with anti-clockwise rotation the nut (9), of the threaded rods (1) for 30° rotation of the lateral pole, until the two holes (12), on the support of the pole (15) and on the beam C (16), are lined up.

5) Reassemble the bolt (M16), in the position (12), without tighten it.

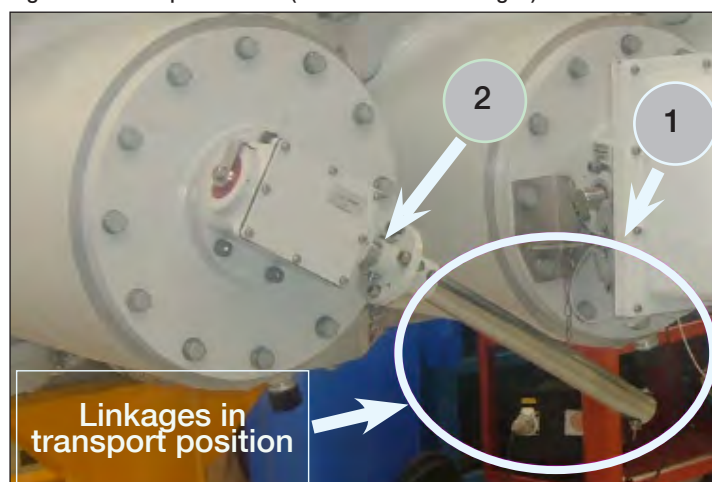
6) Find alignment of the two pin holes, between support of the pole (15) and beam C (16), and place the relevant spring pins (13).

7) Tight first the bolt M16 (11) and then the bolt M16 (12) with torque 180 Nm.

8) Assemble circuit breaker and disconnecter linkages as per specific instructions

For the linkages installation, the LCC (Local Control Cubicle) cable connection, the TA cables and the SF<sub>6</sub> gas filling procedure, refer to the specific manuals.

Fig. 3 Shaft and pin removal (Disconnecter's linkages)



key fig.2

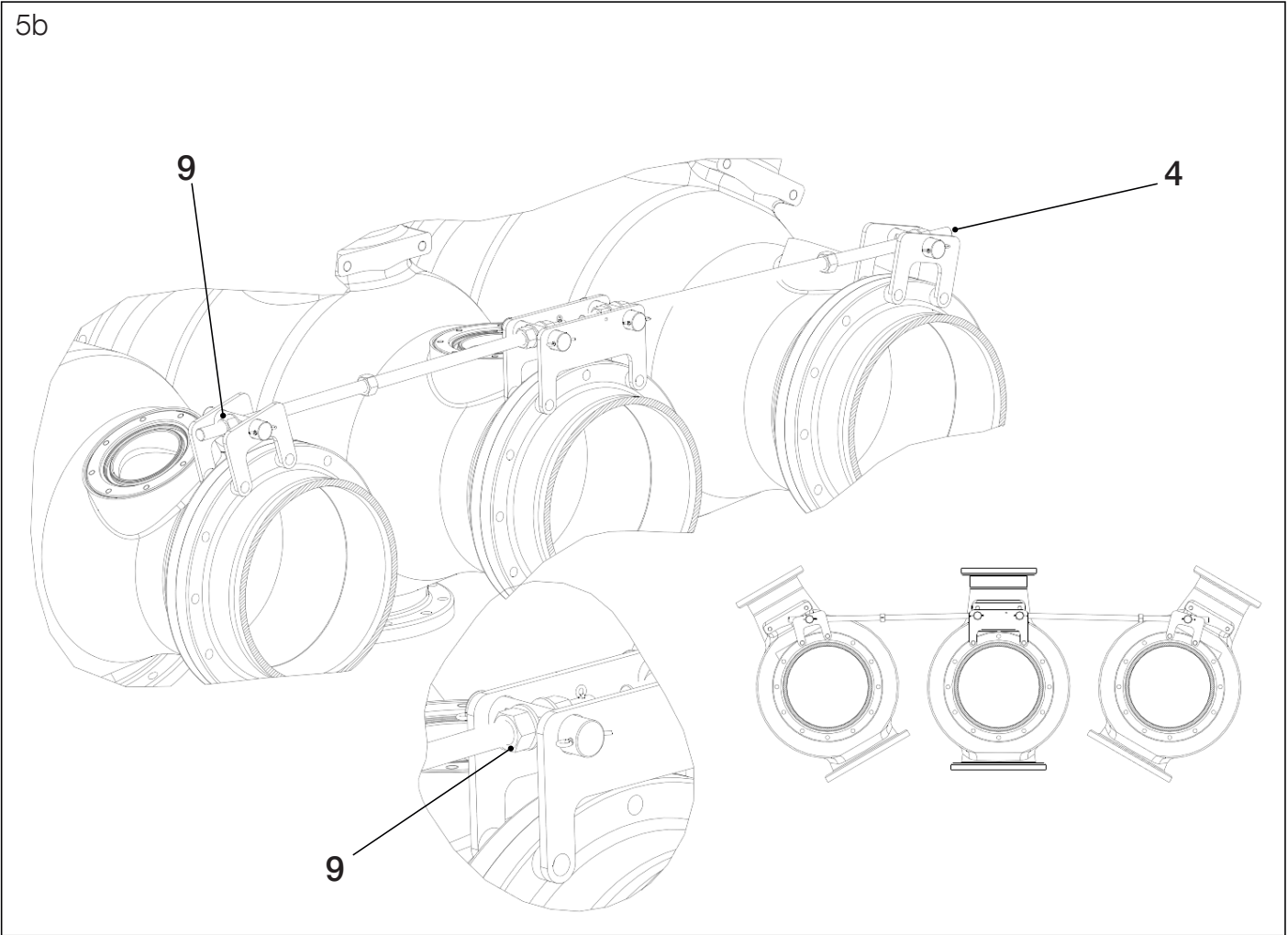
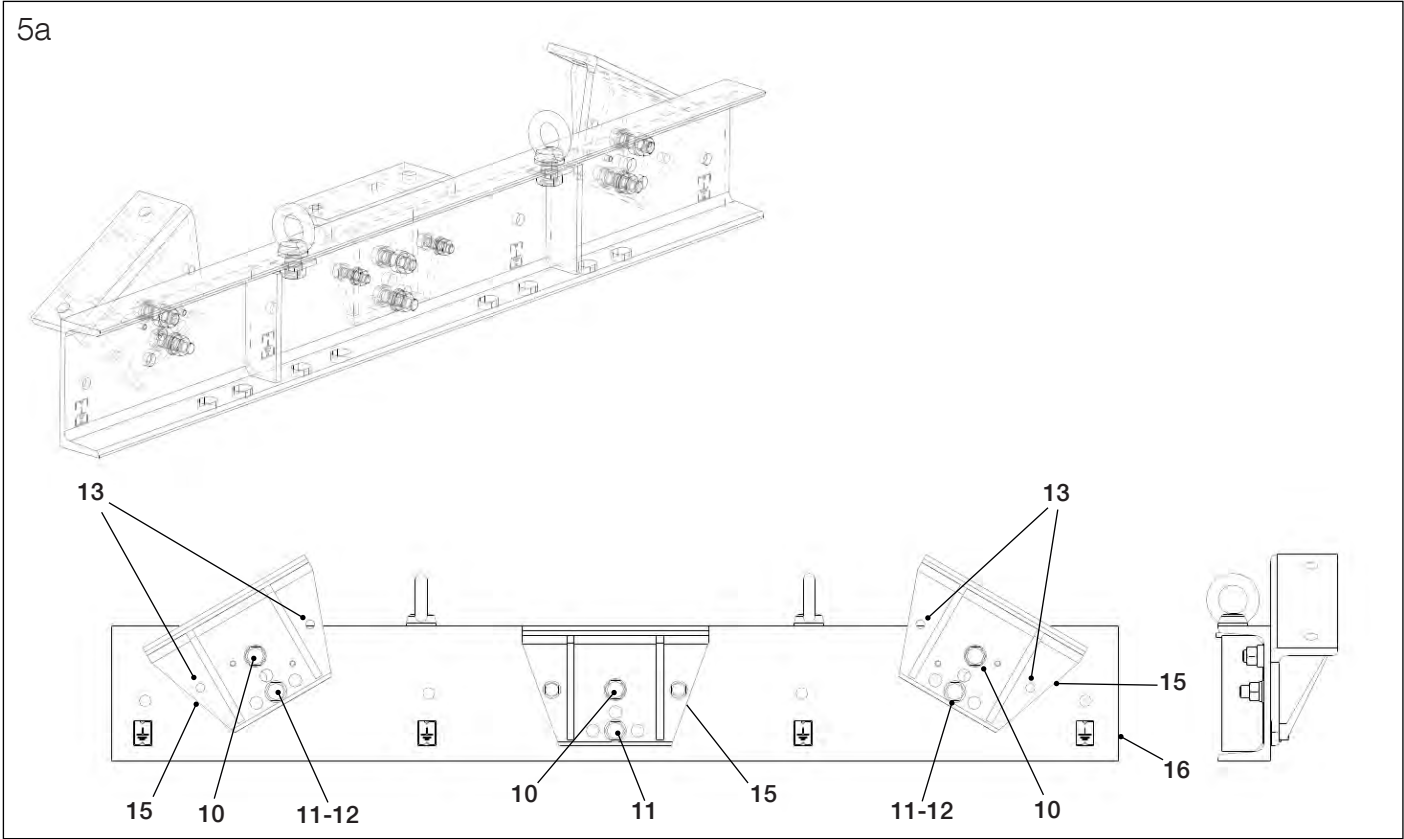
- 1. shaft
- 2. pin

Fig. 4 Operating position linkage



fig 5a. supports on the beam

fig 5b threaded rod detail





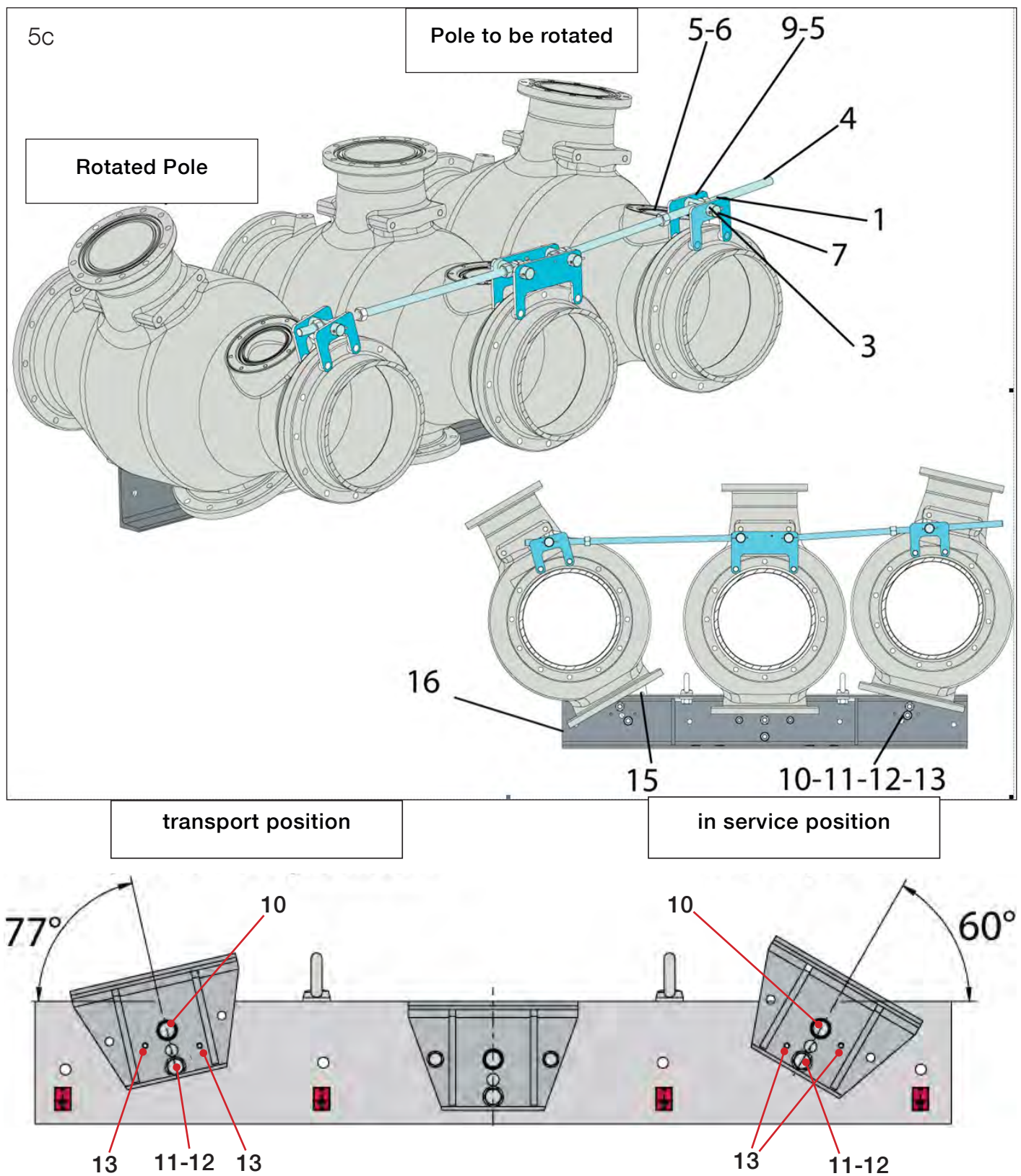


Fig. 5 C Transport and in service position of the pole

Key figures 5a, 5b, 5c:

- |                 |                  |
|-----------------|------------------|
| 1. Metal square | 10. Bolt M16     |
| 3. Pivot        | 11. Bolt M16     |
| 4. Threaded rod | 12. Hole         |
| 5. Washer       | 13. Spring pin   |
| 6. Nut          | 15. Support pole |
| 7. Split        | 16. Beam C       |
| 9. Higher nut   |                  |

Figura 6 – Lateral DS drive in service position



Figura 7 - Bay linkages in shipping unit

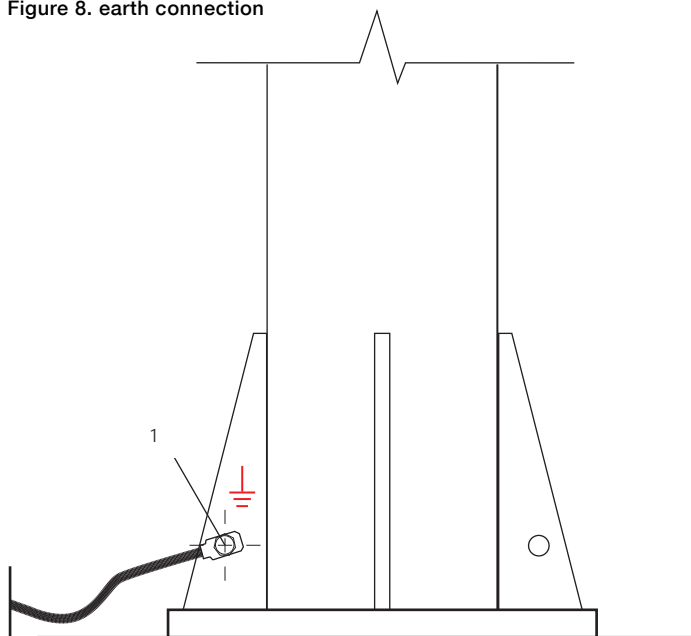




## 4.5. Earth Connection (Fig. 8)

Perform the earth connection by bolting the earth conductor to the proper hole (1). It is recommended to clean and grease the zone surrounding the hole and, after completing the assembly, cover the connection with grease.

Figure 8. earth connection



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# **M0 SBB OPERATING PRINCIPLE AND SIGNALLING**

## Indice

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1.1.	Technical Data	4
1.2	Indicator	4

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<b>Fig. 1</b>	Combined Disconnecter earthing switch for PASS M0 Single Bus Bar	3
<b>Fig.2</b>	One position indicator	4
<b>Fig. 3/4</b>	Two position indicator	4

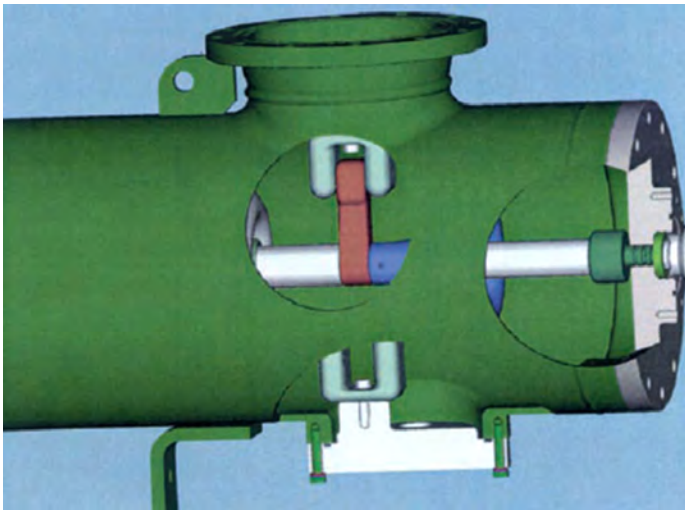
# 1. General Description

PASS is equipped with a combined disconnector/earthing switch moved by the BES7 drive.

The operating principle (patented) is based on the rotary motion of the contact which can be closed on the Bus Bar, earthed or left in the neutral position; the operation can be performed either manually or by the electrical control unit.

The mechanism has a limited number of mechanical components, it is intrinsically reliable, and maintenance free.

This modular design can be applied to PASS M0 in Single Bus Bar configuration, Double Bus Bar configuration and on all the bushings: Bus Bar or Line Side.



**Fig. 1.** Combined Disconnector earthing switch for PASS M0 Single Bus Bar. The contact is closed on the bus bar (0° position). With a 90° rotation the disconnector is in neutral position (open); with a 180° rotation the disconnector is earthed.

## **All combinations are possible.**

In both cases, Single Bus Bar and Double Bus Bar, the position of the combined disconnector/earthing switch is always clearly indicated by an indicator which is mechanically coupled to the shaft.

In addition to this, a visual confirmation is possible by means of an inspection window in the enclosure.

The disconnector/earthing switch may be operated manually, in case of emergency, by means of a hand crank.

For the PASS M0 the run is 0 – 90°

In zero position is open, in 90° position is in earth position.

## 1.1 Technical Data

### Sezionatore combinato di terra

Drive 3 poles motor operated  
Rated supply voltage of auxiliary circuits 110 – 125 – 220 Vdc  
Emergency manual operation possible (hand-crank)  
Contact position visible through inspection window.

## 1.2 Indicator

Two Position Indicator is present only for PASS M0 SBB with ball Disconnect/earthing switch

Fig. 2 One Position Indicator

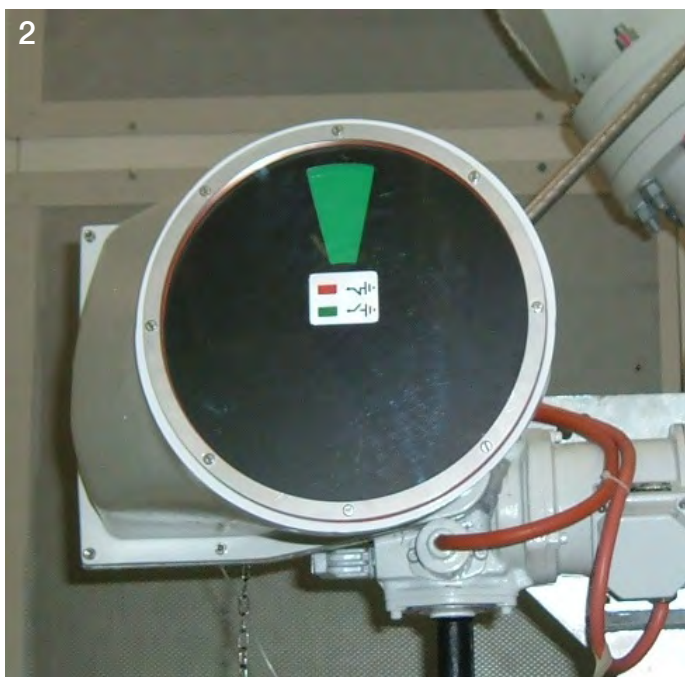
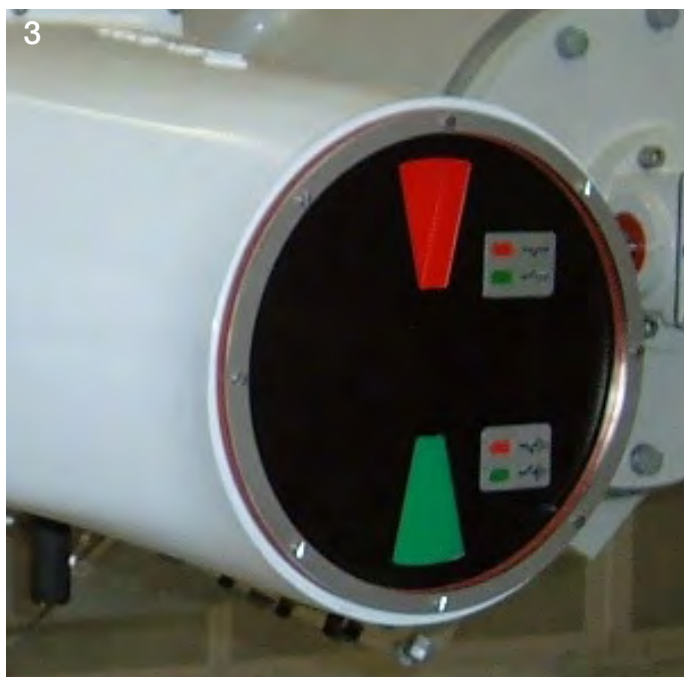


Fig. 3-4. Two Position Indicator



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Doc. 2GJA700338

Rev. D 02/2013 [LM]

M0 DBB Operating Principle and  
Signalling

# **M0 DBB OPERATING PRINCIPLE AND SIGNALLING**

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<b>fig.1</b>	sezionatore di linea/terra combinato per la configurazione DBB	
<b>fig.2-3-4</b>	Segnalatore a tre posizioni	

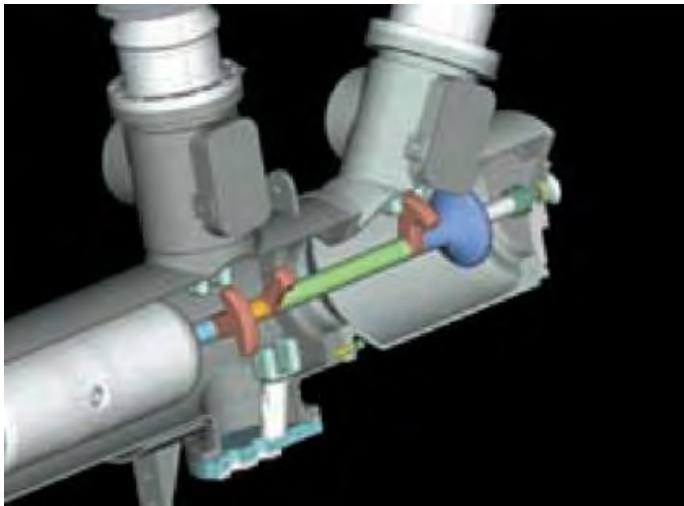
pag. 3
pag. 4

# 1. General Description

PASS is equipped with a combined disconnecter/earthing switch moved by the BES7 command. The operating principle (patented) is based upon the rotary motion of the contact which can be closed on the Bus Bar, earthed or left in the neutral position by the utilization of a manual and electrical control unit.

The mechanism is composed of a minimal number of mechanical components and it is intrinsically reliable, and maintenance free.

fig. 1 combined disconnecter/earthing switch for the DBB configuration



**The combined disconnecter/earthing switch for the DBB configuration is achieved using a combination of two disconnecter/earthing for the SBB. In the picture the right contact is closed whereas the left one is open. In this case the rotation is on 360°.**

All combinations are possible. In both cases, Single Bus Bar and Double Bus Bar, the position of the combined disconnecter/earthing switch is clearly indicated at all times by an indicator which is mechanically coupled to the shaft. In addition to this, a visual confirmation is possible by means of an inspection window in the enclosure.

The disconnecter/earthing switch may, in an emergency, be operated manually by means of a crank.

## 1.1 Technical Data

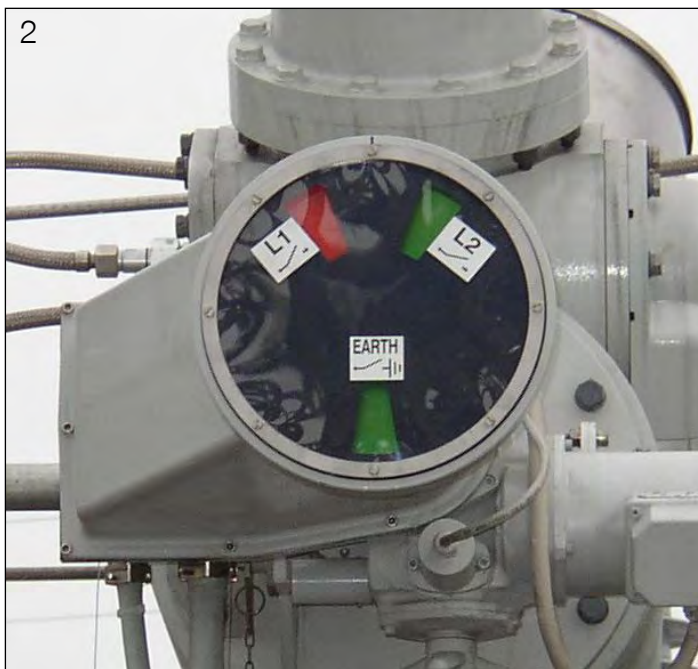
### Disconnecter/Earthing Switch

Drive.....three poles motor operated  
rated supply of the auxiliary circuits.....110 – 125 – 220 Vcc  
Emergency manual operation possible (hand-crank).  
Contact position visible through porthole.

## 1.2 Indicator

Three position Indicator is present only for PASS M0 DBB

Fig. 2-3-4 Three Position Indicator



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Doc. 2GJA708349  
Rev. D 07/2013 [LM]  
Title: High voltage  
cable end enclosure 72 kV - 170 kV



# **HIGH VOLTAGE CABLE END ENCLOSURE 72 kV - 170 kV**

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2. MAIN COMPONENTS	pag. 3
2.1 Assembly (Fig. 2)	pag. 4

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Fig. 1. Cable end	pag. 3
Fig. 2. Cable end assembly	pag. 5



NOTE: This document provides general information that does not take into account specific design requirements. Please refer to specific design diagrams for the operating and interlock principle of the equipment.

# 1. General Description

An high voltage input/output cable can be connected to the bay by means of a cable end, encased in a metal enclosure. Such an enclosure can be flanged vertically or horizontally to the multifunctional hybrid device or to the GIS.

# 2. Main Components

The CABLE END is essentially made up by (fig.1): enclosure (1); Support insulator (2); Threaded rod M12 (3); nut M12 (4); bar (5); clamp (6); flange (7); socket (8); screw M10 (9); Socket side VT, if available (10); connector (11); cable end (12); Threaded rod M12 (13); nut M12 (14); flange (15); seals (16, 17); connecting piece (18).

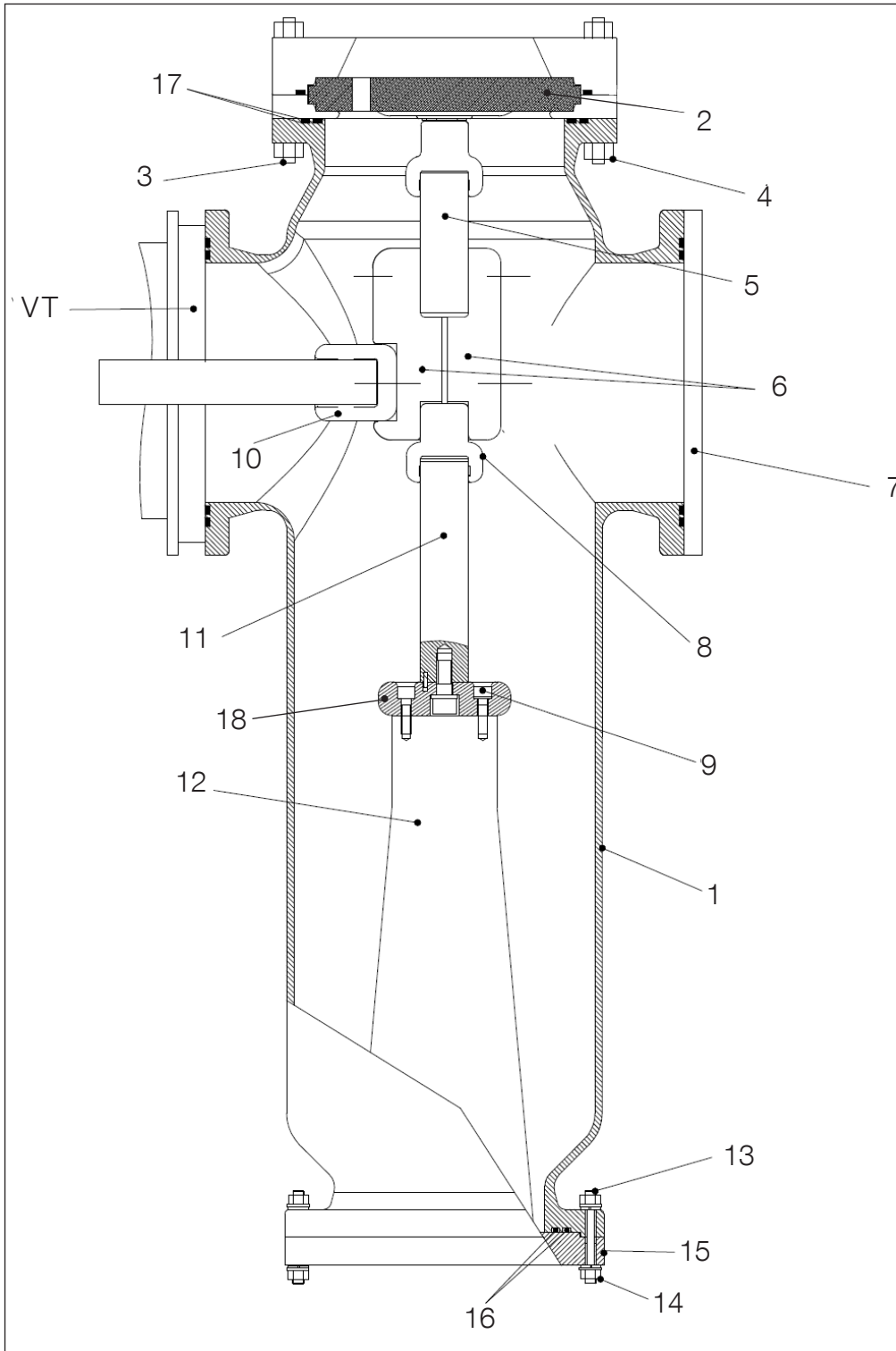


Fig. 1. Cable end

Key fig. 1:

- 1. enclosure (1);
- 2. support insulator
- 3. threaded rod M12;
- 4. nut M12;
- 5. rod;
- 6. half-shells;
- 7. cover;
- 8. contact holder (glass) ;
- 9. screw M10;
- 10. contact holder side VT (current transformer), if any;
- 11. connection rod;
- 12. cable end;
- 13. threaded rod M12;
- 14. nut M12;
- 15. flange;
- 16/17. gaskets
- 18. Connecting piece



## 2.1 Assembling cable end (Fig. 2)

**The cable end is generally shipped already mounted on the module.**

If installation on site is necessary, the operation must be performed by ABB personnel or specialized personnel. A high voltage input/output cable can be connected to PASS M0 DCB through a cable end, closed in a metal enclosure. The enclosure is mounted on the lateral line L1 using adaptation enclosures. Everything forms a single container, the enclosure of the cable end is pressurized with gas  $\text{SF}_6$  such as PASS M0 DCB.

To fix a cable end to the pole, follow this procedure:

- 1) Bring enclosure (1) close to the isolating disc (2) of the central pole fitting the flange (with the seals mounted) on the threaded rods M12 (3);
- 2) Fasten with nuts and washers (4);
- 3) Mount the socket (8) with the relating washer and bolt M12 (19);
- 4) Mount the cable end (12) on the enclosure (1) fastening it with the threaded rods (13), washers and nuts (14);
- 5) Assemble the connector (18) to the head of the cable end using washers and nuts M10 (9);
- 6) Keeping the rod in position (5), tighten the clamps (6) by means of washers and nuts M12 (20);
- 7) Close with the cover, (7), bolts (21), washers and nuts (22);
- 8) Repeat the sequence from 1 to 7 for lateral cable ends.

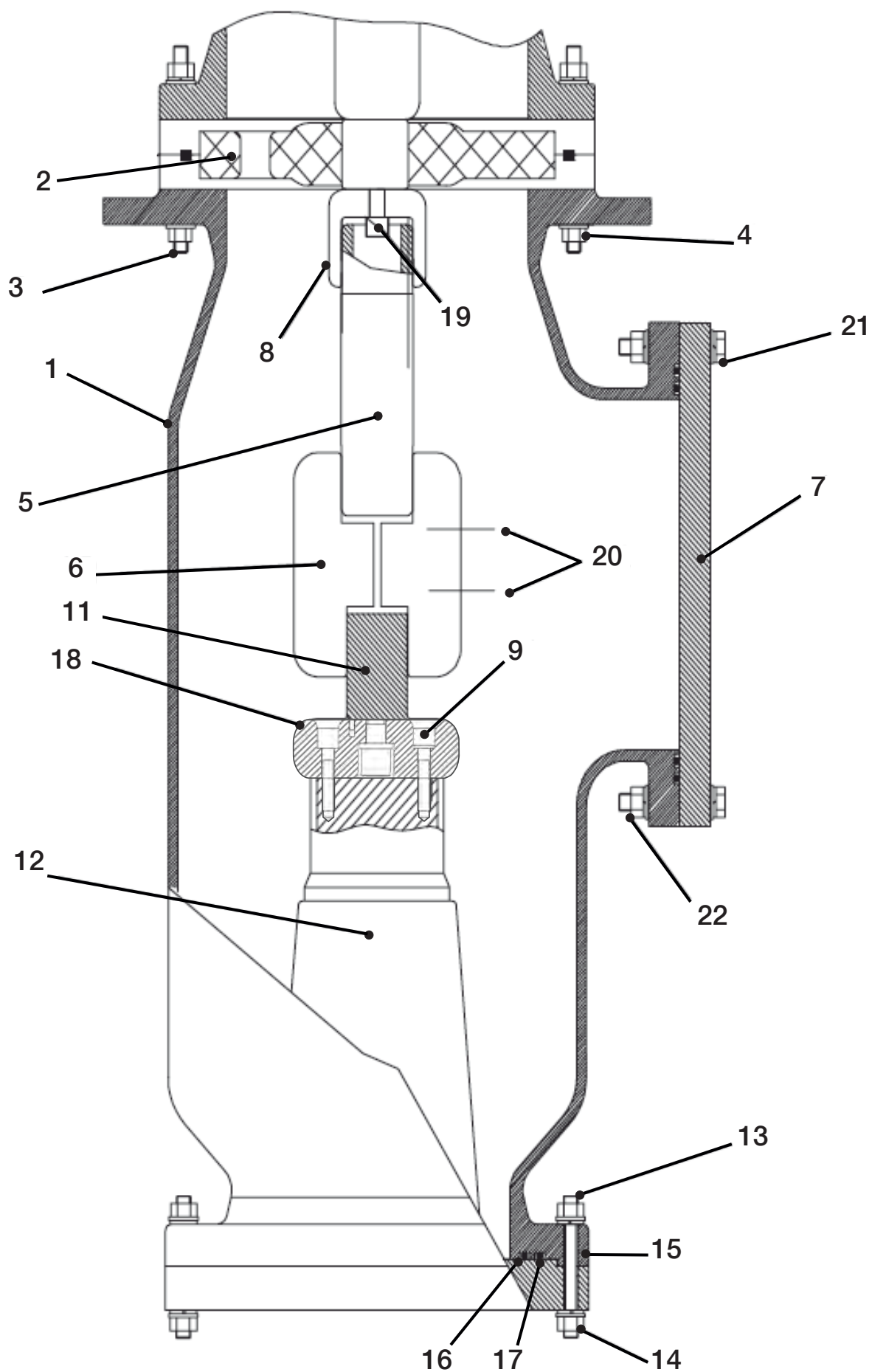


Fig. 2. Cable end assembly

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Doc. 2GJA700404

Rev. E 03/2013 [LM]

Titolo:

Density monitor Type ZMJ 100

# **DENSITY MONITOR**

## **Type ZMJ 100**

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fig 1.	Density monitor application	4
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**Note:** construction characteristics and functional as per our dwg 2GJA306823

# 1. Generality

**SF<sub>6</sub> switchgear used to be monitored by pressure gauges**, where the operator had to determine the reading of the gauge by choosing a temperature band to ensure that the density of gas inside the switchgear is sufficient for safe operation. Today, Sulfur hexafluoride (SF<sub>6</sub>) switchgear is controlled by using gas density monitors.

The main advantage the density monitors have over the pressure gauges is that the density monitors will automatically redeem the reading from any changes in the pressure which are resulted from changes in temperature. Thus, ZMJ Series Density Monitor will always indicate the relative gas pressure of that at +20 C, regardless of the ambient temperature. Hence the reading obtained actually reflects the gas density. The Density Monitors have up to 4 micro switch contacts for alarm and blocking at preset pressure levels. The ZMJ series of SF<sub>6</sub> gas density monitors are specifically designed to monitor the gas density of high voltage and medium voltage gas insulated switchgear, circuit breakers and apparatus.

## 2. Characteristics

### 2.1 Technical characteristics

- Nominal diameter size: 100 mm
- Case material: Stainless Steel
- Cover in Stainless Steel
- Gas connection: by means hexagonal nut threaded M30x2 in stainless material with double O-RING
- Sensitive element: Bourdon tube made of brass
- Movement: in brass
- Electrical contacts: in Silver-Nickel (Ag80Ni20) with micro switches
- Electrical connections: with secondary terminal box and cable glands
- Dial with either, scale MPa and colored sectors
- Application: outdoor
- Aeratine system: by means one aerator
- Anti-shock and vibration system equipped
- Temperature compensation by bimetal band

## 2.2 Features

- Measuring range:  $-0.1 \div 1 \div 1,5$  MPa relative
- Functional range (standard):  $-30^{\circ}\text{C} \div +60^{\circ}\text{C}$   
( $-60^{\circ}\text{C} / +80^{\circ}\text{C}$  upon request)
- Electrical contacts: from 1 to 4
- Rated voltage: 110 Vdc - 220 Vdc
- Nominal current at 110 Vdc 5°
- Nominal current at 220 Vdc 5A
- Breaking capacity at 110 Vdc with  $L/R < 20$  ms 0.2 A
- Breaking capacity at 220 Vdc with  $L/R < 20$  ms 0.1 A
- Rated short time withstand current 100 A / 30 ms
- Insulation between contacts and to ground: 2000V at 50Hz for one minute
- Protection: IP55 with protection cover
- Accuracy at  $20^{\circ}\text{C}$ : 5 kPa
- Accuracy on operational range: 2,5 s.v.f.s.  
(with reference at nominal isochoric curve of \ compensation and gas SF6 or Mixed Gas fields)
- Max Temperature gradient:  $10^{\circ}\text{C}/\text{h}$
- Leakage rate:  $1 \times 10^{-6}$  cm<sup>3</sup> /sec.

## 2.3 Filling pressure (at $20^{\circ}\text{C}$ )

- Check project single line diagram.

## 2.4 Contact setting check

- Contact setting refers to dedicated single line diagram
- Test purpose is to establish real contact setting of mcb; the measured pressure at contact switching and actual ambient temperature are compared with default value. The default value can be obtained by correlating the contact features with the ambient temperature at measure time

### Check methods

- at  $20^{\circ}\text{C}$  (typically in laboratory)  
test is performed with N2  
pressure gauge reference should have accuracy of 0.25 % max

#### procedure:

- fix DM to test equipment with same position as in service
- connect mcb terminals to electrical circuit for switching signal
- stabilize DM in temperature controlled room for 24 hrs before test
- fill DM with gas till to rate pressure (diagram)
- slowly reduce the pressure till to contact switches
- at switching pressure gauge reading must be recorded
- compare pressure gauge reading to P setting at  $20^{\circ}\text{C}$
- difference should be no more than  $\pm 1\%$  of full scale
- repeat test for other contacts setting

- at ambient temperature (typically at site)  
test is performed with SF6 or gas mixture (as per diagram) pressure gauge reference should have accuracy of 0.5 % max

#### procedure

- fix DM to test equipment with same position as in service
- connect mcb terminals to electrical circuit for switching signal
- take ambient temperature measure by thermometer placed one meter from DM under test, and in convenient position to minimise wind and sun effect
- fill DM with gas till to rate pressure (diagram)
- slowly reduce the pressure till to contact switches
- at switching pressure gauge reading must be recorded
- compare pressure gauge reading to P default at ambient temperature by

$$P \text{ default} = ((P_{\text{actual}} - 20) / 10 * 0,05 * P_{\text{setting}}) + P_{\text{setting}}$$

- difference should be no more than  $\pm 2\%$  of full scale
- repeat test for other contacts setting



# 3. Density Monitor Replacement



Before the replacement of the density monitor, the PASS MODULE MUST BE OUT OF SERVICE !

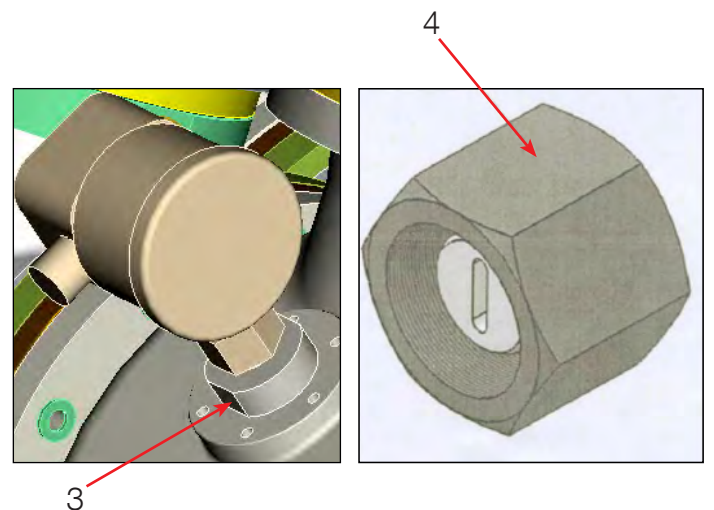
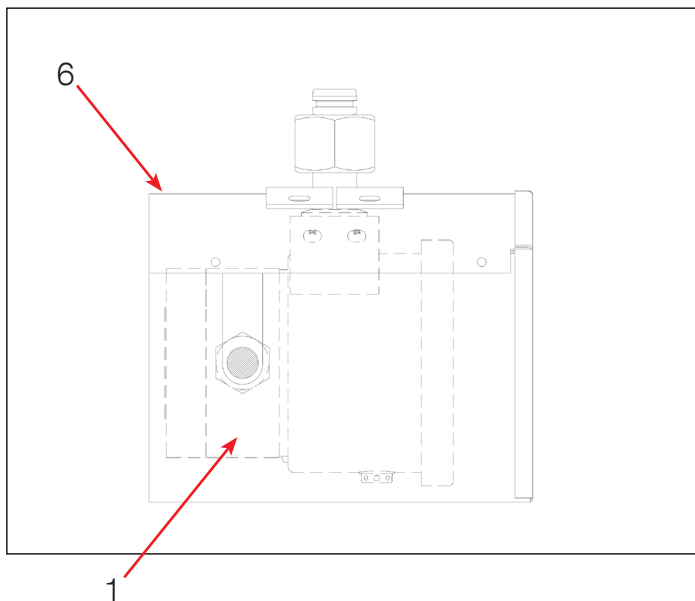
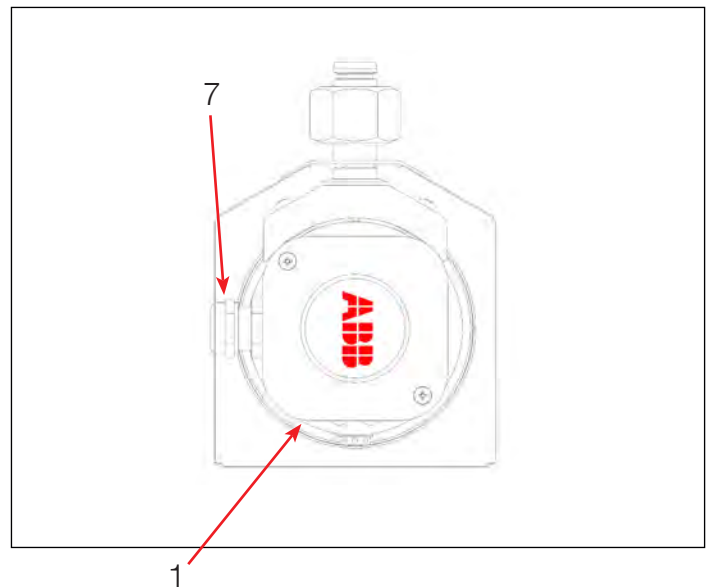
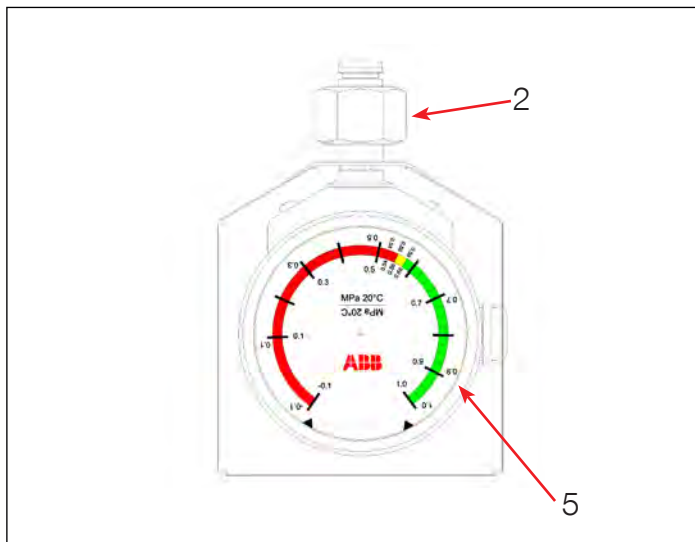
## LEGEND:

- |                             |                    |
|-----------------------------|--------------------|
| 1. Low voltage terminal box | 5. Scale [TYPICAL] |
| 2. Hexagonal nut            | 6. Cover           |
| 3. Valve                    | 7. Cable glands    |
| 4. Cap                      |                    |

Please follow the following procedure in order to replace the density monitor:

- 1) disconnect the low voltage cable from terminal box (1);
- 2) unscrew hexagonal nut (2) using spanner 36, This is necessary to close the valve (3),
- 3) unscrew hexagonal nut (2) definitely using the same spanner 36
- 4) cover the valve (3) using its stopper (4) if there isn't a new density monitor available immediately
- 5) If there is available a new density monitor, repeat the operation following the steps in the reverse order (3-2-1).
- 6) Check the functionality of the new density according to the erection and commissioning manual and fill the value on the site test report.

fig. 1 Density Monitor Application



**Notes:**

If you have some comments we kindly ask You to write that here below and send us this page back.  
Thank You for your collaboration.

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

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# Voltage Transformer Type VTA



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# 1. General Description

Type VTA-72.5...245 kV is a single-phase SF6 gas insulated voltage transformer. The electrical and mechanical ratings and the construction are in accordance with the relevant rules and standards IEC.

## 1.1. Components

The active part consists of:

- A rectangular core (columns) made of low-losses magnetic steel sheet.
- One or more secondary windings placed on one of the core columns.
- The primary winding, concentric to the secondary and consisting of a single coil. The winding fixing methods allows the transformer to be mounted in any position.

The position in which the equipment has to be loaded on the vehicle is marked on the packaging in order to protect the windings against an excess of axial strength during the transport.

Every transformer is normally equipped with transport shock / tilt indicators; such indicators must be checked before mounting the transformer to the switchgear. If an indicator has operated, the transformer should not be mounted before having contacted ABB S.p.a. PPD HV.

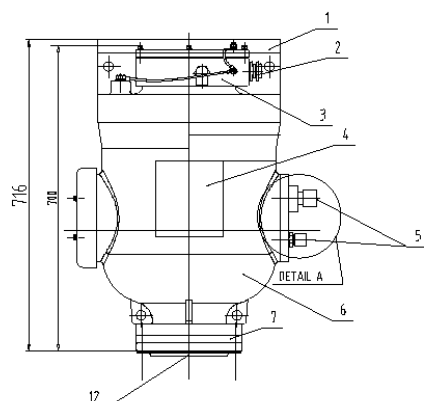
The barrier insulator, fixed to the enclosure through flanges, ensures the transformer's tightness.

For the exact dimensions and the main components, refer to the outline drawing in figure 1.

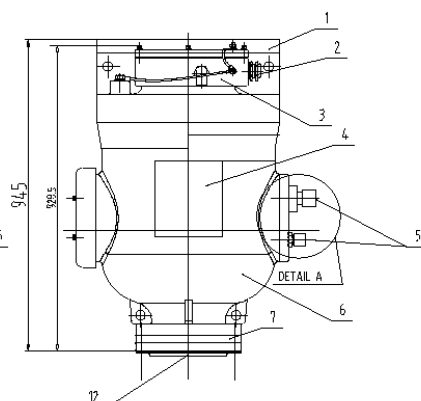
# LEGEND:

- 1 Transport frame
- 2 Cable gland PG21
- 3 Secondary terminal box
- 4 Nameplate
- 5 SF6 gas filling valve & density Monitor connection valve
- 6 Aluminium casted enclosure
- 7 Insulator
- 8 Rupture disc
- 9 Earth connection point
- 10 Flange
- 11 Secondary earthing connection of terminal box
- 12 Shipping cover

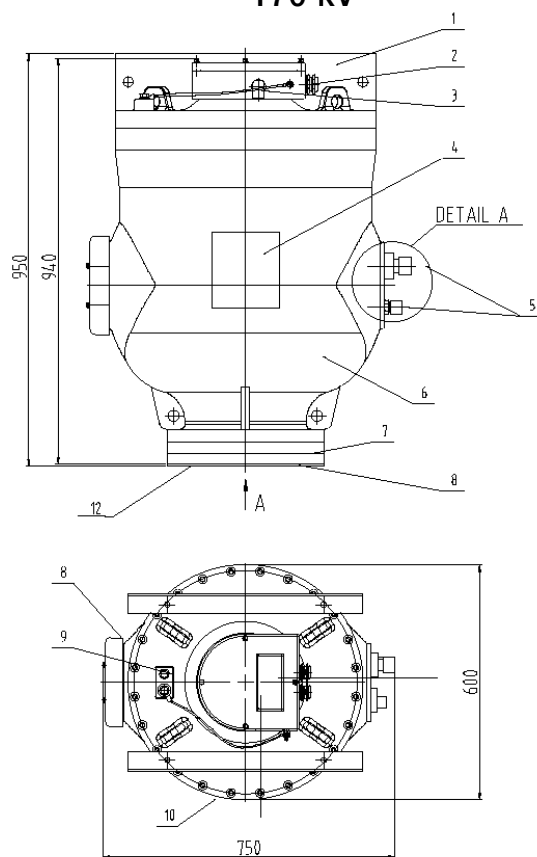
72,5 kV



123-170 kV



170 kV



245 kV

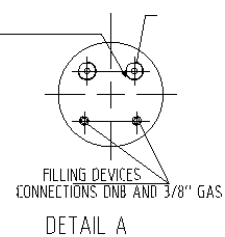
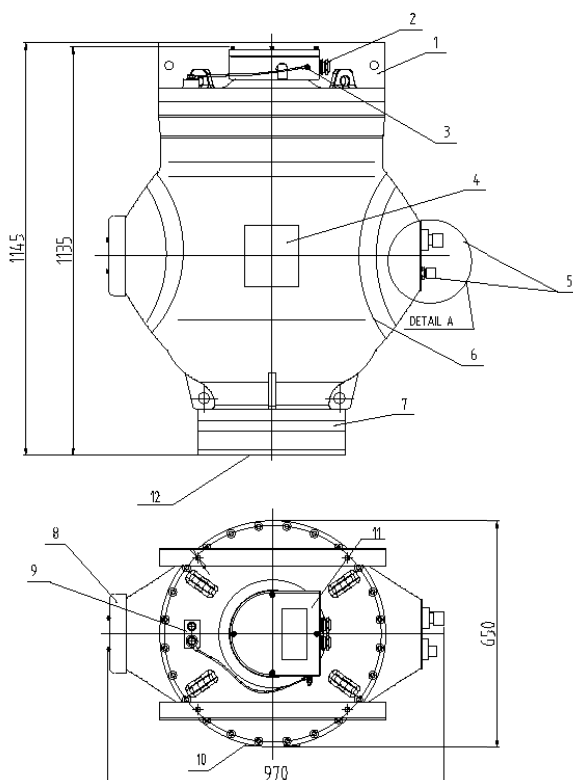


Fig. 1

1.2. Nameplate

The nameplate with electrical, mechanical and pressure data is attached on the secondary terminal box.  
A diagram nameplate is located inside the secondary terminal box.

**ABB**

TRASFORMATORE DI TENSIONE VTA

STANDARD  
IEC 60044-2

Tipo JDQXF  ZHW Frequenza nominale  Hz N°

Livello di isolamento  kV Disegno N°

Fatt. di tens.  Temperatura di lavoro  °C

Press. nom. di Riempimento/Allarme/Min. a 20°C  MPa

Rapporto kV/V	Morsetti	Classe	VA	Pot. Term. VA
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Peso SF6  kg    Peso totale  kg    Data

Fig. 2 Targa

1.3. Accessories

The VT is provided with the following accessories:

- Two DN8 gas inlets for filling and control
- One rupture disc
- One valve for the connection of the density manometer
- Arc detector device (optional)

1.4. Gas filling valve

Two Gas filling valves fixed to the cover allow SF6 gas filling or the connection to a device for moisture or pressure measurement. It is possible to connect the gas circuit of three transformers at the same time.

1.5. Secondary Terminal Box

To access the secondary terminals, remove the steel protective cover. The secondary windings and the neutral end of high-voltage winding are connected by a link to the insulating block grounding terminals. These grounding terminals are connected to the main grounding contact (fig. 3).

1.6. Safety device

A predetermined breaking device (rupture disc) is located on the side of the transformer. The device, which is maintenance free, protects against any harmful overpressure.



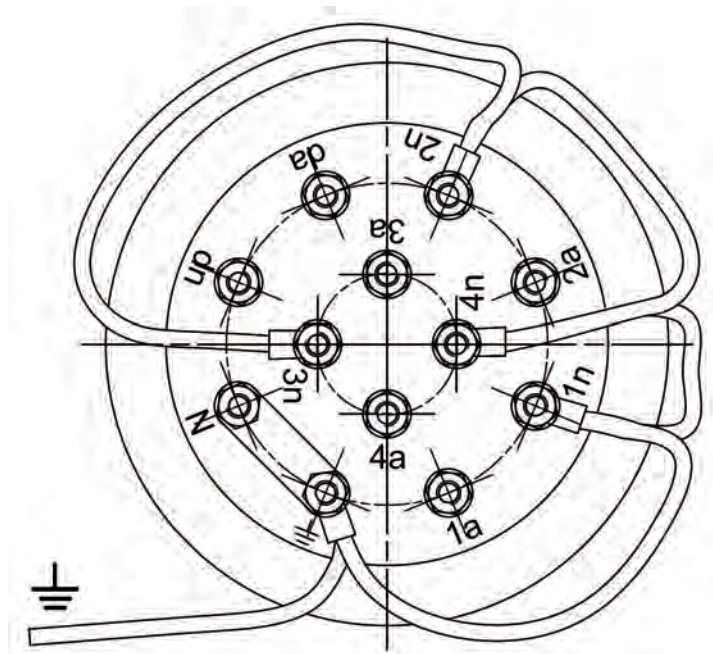


Fig. 3 Secondary Terminal Box

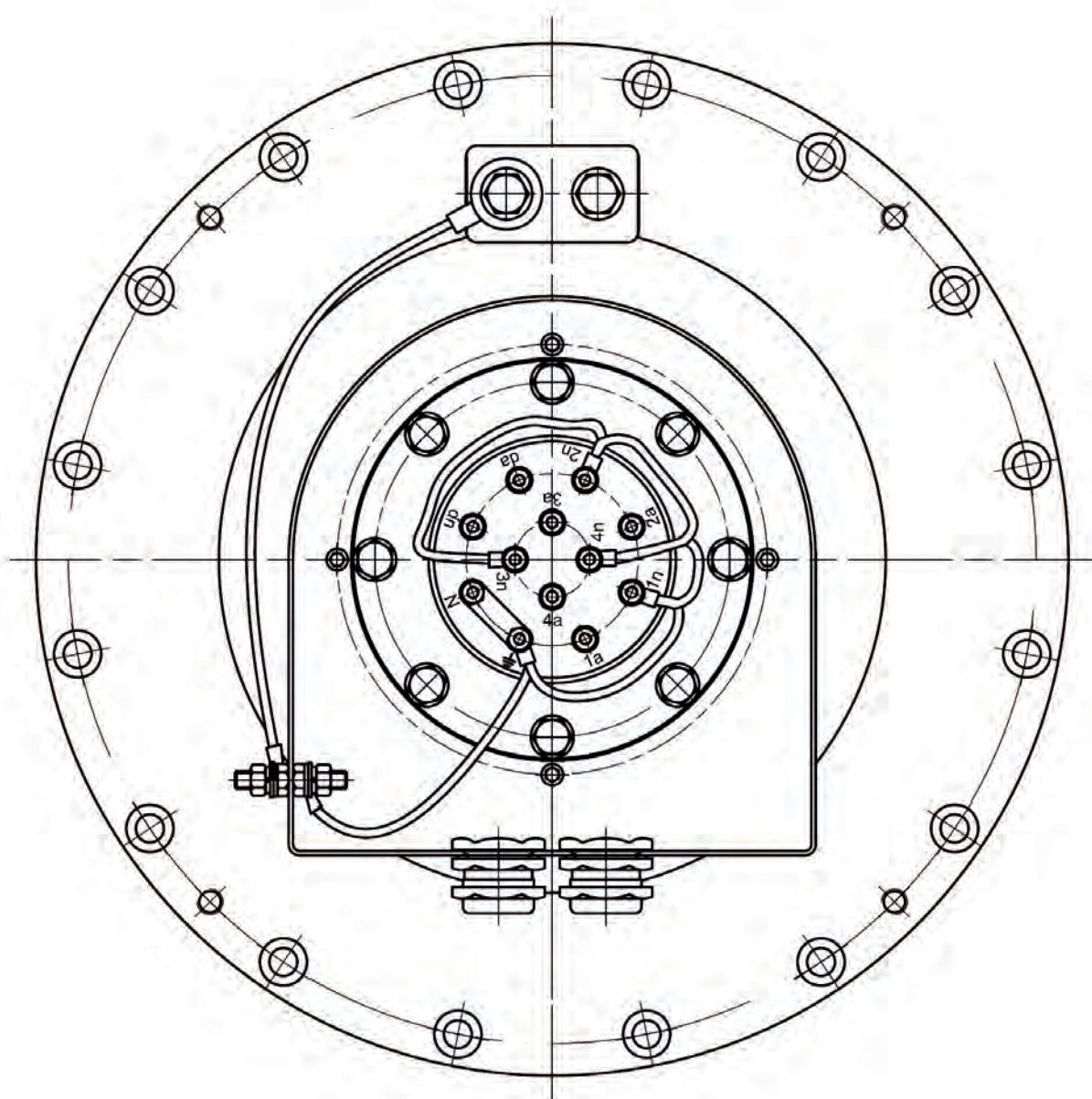


Fig. 4 Secondary Terminal Box grounding connection

## 2. Erection and commissioning notes

### 2.1. Shipping

Each transformer is shipped in vertical position with an internal SF6 gas pressure of no more than 0.03 MPa at 20°C. The high voltage interface area (HV insulator) is protected by a special transport flange. During transport, observe the conventional symbols marked on the packaging and/or on the transformer.

### 2.2. Checking upon arrival

On arrival, the transformers and their packaging must be checked immediately for any sign of damage or tampering as indicated in paragraph "inspection". All the transport shock / tilt indicators must be checked. In case it's verified any evident sign of damage or any shock / tilt indicator, keep all the parts, including the packaging, and notify it to the carrier and ABB Spa PPHV.

### 2.3. Moving

Move the equipment in its packaging to the installation site by following the instructions of the symbols marked in the packaging. If the transformer has to be moved without packaging, use the special lifting lugs placed at the cover or at the transformer enclosure. Use only two lugs for lifting – vertically or horizontally. To protect the interface area, use always the transport frame.

### 2.4 Storage

In case the transformer should be stored before the installation, it must be kept in a dry, sheltered place, in a vertical position. In case the transformer needs to be stored without packaging, it will have to be fixed on a ground in order to avoid accidental overturning. If the transformer has to be stored for more than six months, the internal gas pressure must be checked monthly. In case of leakage of pressure contact ABB before starting the erection.

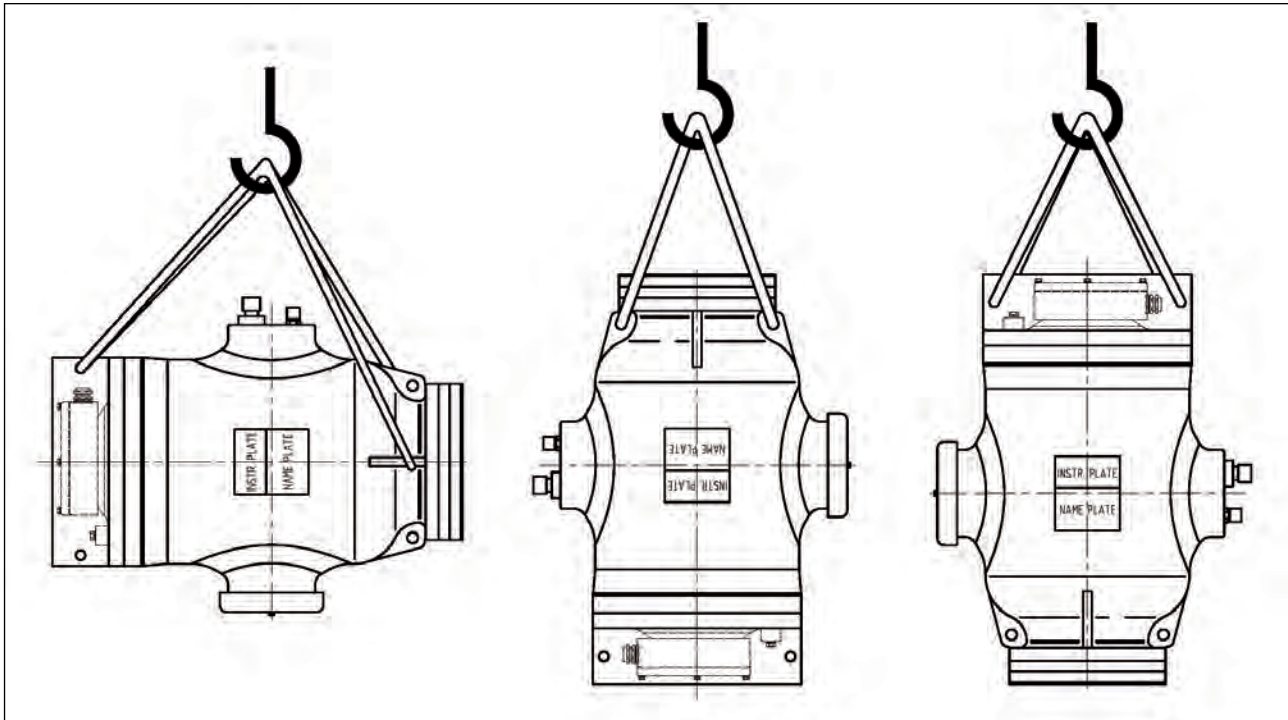


Fig. 5 Moving

## 2.5 Unpacking

The packaging should be opened only at the installation site. Remove the packaging carefully to avoid any damage to the contents.

## 2.6 Ispezione

After unpacking, the following items shall be carefully inspected:

- gas filling valves;
- rupture disc;
- secondary terminal box (for any damage).

The transport pressure of the transformer shall be checked using the filling valves, by means



**Warning: for the safety of personnel and equipment, the transformer cannot be handled if the internal gas pressure is higher than 0.03 MPa at 20°C. The internal gas pressure must always be higher than the atmospheric pressure to ensure the due dielectric properties.**

## 2.7 Erection

Proceed in the following way:

- remove the special transport frame;
- if necessary, clean gaskets and electrical contact areas of the coupling flange;
- make high-voltage connection over the contact areas of the insulator;
- Couple the transformer to the coupling flange ensuring original gaskets are fitted. Ensure these gaskets are greased and have no mechanical damage.

## 2.8 Gas Filling

The rated filling pressure of the SF6 reported on the VT nameplate is referred to an ambient temperature of 20°C at sea level; or different temperatures the pressure shall be set according table 1 (next page).

The humidity content must be checked after gas filling but before the commissioning.

The transformer is ready for service if the humidity content is less than 500 ppm vol. (at 20°C).

### Use of the table 1:

- 1) First read the rated filling pressure of compartment on the nameplate, then choose the relevant column (select it starting from row 1).
- 2) Vertically move up to the relevant row corresponding to the real temperature measured (select it starting from column 1)
- 3) The corresponding value in Table 1 is the correct filling pressure.

The pressure should also be correct as a function of the altitude of the installation; adjustment needed is approximately increase of 0,01 MPa rel. every 1000 m on the sea level.



- The VTA is shipped with SF6 pressure 0.02 - 0.03 MPa rel. at 20°C.
- When VTA is moved the SF6 pressure shall be at 0.02 – 0.03 MPa rel. at 20°C.

After connecting the gas filling equipment (gas cylinder or compressor unit), let the gas flow for a few seconds to ensure that the gas hose is filled.

Then insert the connection hose in the gas filling valve (item 5 fig. 1).

Check the nameplate for rated filling pressure at 20°C. Adjust it for the actual temperature (and, if needed, for the altitude) and fill VT to the right pressure.

If the pressure didn't stabilised, add some gas. After the filling and the removing of the charging device, check with a leak detector the tightness of the gas inlet valve and all the other transformers joints, making particular attention to the devices connected to the site (densimeter) and the connections to the device.

## 2.9 Connection to circuits



**DO NOT REMOVE THE GROUNDING LINK OF EACH SECONDARY WINDING.** This prevents the secondary winding from reaching dangerous levels at the secondary terminals. If a delta connection is required on the secondary windings, **CONNECT THE SECONDARY TERMINAL OF ONLY ONE OF THE THREE TRANSFORMERS IN THE GROUP TO EARTH.** Not complying with this rule will short-circuit the transformers and therefore creating irreparable damage. To this regard, it should be recalled that the transformer can withstand a short-circuit on the secondary winding for a maximum of one second.



PRESSIONE DI RIEMPIMENTO IN FUNZIONE ALLA TEMPERATURA																		
Temp [°C]	2,5	2,6	2,7	2,8	2,9	3,0	3,1	3,2	3,3	3,4	3,5	3,6	3,7	3,8	3,9	4,0	4,1	4,2
-26	1,945	2,030	2,114	2,198	2,283	2,367	2,451	2,535	2,620	2,704	2,788	2,873	2,957	3,041	3,126	3,210	3,294	3,378
-24	1,969	2,054	2,139	2,224	2,309	2,394	2,479	2,564	2,649	2,734	2,819	2,904	2,989	3,074	3,159	3,244	3,329	3,414
-22	1,994	2,079	2,165	2,251	2,336	2,422	2,508	2,593	2,679	2,765	2,850	2,936	3,022	3,107	3,193	3,279	3,364	3,450
-20	2,018	2,104	2,190	2,277	2,368	2,449	2,536	2,622	2,708	2,795	2,881	2,968	3,054	3,140	3,227	3,313	3,399	3,486
-18	2,042	2,129	2,216	2,303	2,390	2,477	2,564	2,651	2,738	2,825	2,912	2,999	3,086	3,173	3,260	3,347	3,434	3,521
-16	2,066	2,154	2,241	2,329	2,417	2,504	2,592	2,680	2,768	2,855	2,943	3,031	3,118	3,206	3,294	3,382	3,469	3,557
-14	2,090	2,178	2,276	2,355	2,444	2,532	2,620	2,709	2,797	2,886	2,974	3,062	3,151	3,239	3,328	3,416	3,504	3,593
-12	2,114	2,203	2,292	2,381	2,470	2,560	2,649	2,738	2,827	2,916	3,005	3,094	3,183	3,272	3,361	3,450	3,539	3,628
-10	2,138	2,228	2,318	2,408	2,497	2,587	2,677	2,767	2,856	2,946	3,036	3,126	3,215	3,305	3,395	3,485	3,574	3,664
-8	2,162	2,253	2,343	2,434	2,524	2,615	2,705	2,795	2,886	2,976	3,067	3,157	3,248	3,338	3,429	3,519	3,609	3,700
-6	2,186	2,278	2,369	2,460	2,551	2,642	2,733	2,824	2,916	3,007	3,098	3,189	3,280	3,371	3,462	3,553	3,645	3,736
-4	2,211	2,302	2,394	2,486	2,578	2,670	2,761	2,853	2,945	3,037	3,129	3,221	3,312	3,404	3,496	3,588	3,680	3,771
-2	2,235	2,327	2,420	2,512	2,605	2,697	2,790	2,882	2,975	3,067	3,160	3,252	3,345	3,437	3,530	3,622	3,715	3,807
0	2,259	2,352	2,445	2,538	2,632	2,725	2,818	2,911	3,004	3,097	3,191	3,284	3,377	3,470	3,563	3,656	3,750	3,843
2	2,283	2,377	2,471	2,565	2,658	2,752	2,846	2,940	3,034	3,128	3,222	3,315	3,409	3,503	3,597	3,691	3,785	3,879
4	2,307	2,402	2,496	2,591	2,685	2,780	2,874	2,969	3,063	3,158	3,252	3,347	3,442	3,536	3,631	3,725	3,820	3,914
6	2,331	2,426	2,522	2,617	2,712	2,807	2,903	2,998	3,093	3,188	3,283	3,379	3,474	3,569	3,664	3,760	3,855	3,950
8	2,355	2,451	2,547	2,643	2,739	2,835	2,931	3,027	3,123	3,218	3,314	3,410	3,506	3,602	3,698	3,794	3,890	3,986
10	2,379	2,476	2,573	2,669	2,766	2,862	2,959	3,056	3,152	3,249	3,345	3,442	3,538	3,635	3,732	3,828	3,925	4,021
12	2,404	2,501	2,598	2,695	2,793	2,890	2,987	3,084	3,182	3,279	3,376	3,474	3,571	3,668	3,765	3,863	3,960	4,057
14	2,428	2,526	2,624	2,722	2,819	2,917	3,015	3,113	3,211	3,309	3,407	3,505	3,603	3,701	3,799	3,897	3,995	4,093
16	2,452	2,550	2,649	2,748	2,846	2,945	3,044	3,142	3,241	3,339	3,438	3,537	3,635	3,734	3,833	3,931	4,030	4,129
18	2,476	2,575	2,675	2,774	2,873	2,972	3,072	3,171	3,270	3,370	3,469	3,568	3,668	3,767	3,866	3,966	4,065	4,164
20	2,500	2,600	2,700	2,800	2,900	3,000	3,100	3,200	3,300	3,400	3,500	3,600	3,700	3,800	3,900	4,000	4,100	4,200
22	2,524	2,625	2,725	2,826	2,927	3,028	3,128	3,229	3,330	3,430	3,531	3,632	3,732	3,833	3,934	4,034	4,135	4,236
24	2,548	2,650	2,751	2,852	2,954	3,055	3,156	3,258	3,359	3,461	3,562	3,663	3,765	3,866	3,967	4,069	4,170	4,271
26	2,572	2,674	2,776	2,878	2,981	3,083	3,185	3,287	3,389	3,491	3,593	3,695	3,797	3,899	4,001	4,103	4,205	4,307
28	2,596	2,699	2,802	2,905	3,007	3,110	3,213	3,316	3,418	3,521	3,624	3,726	3,829	3,932	4,035	4,137	4,240	4,343
30	2,621	2,724	2,827	2,931	3,034	3,138	3,241	3,344	3,448	3,551	3,655	3,758	3,862	3,965	4,068	4,172	4,275	4,379
32	2,645	2,749	2,853	2,957	3,061	3,165	3,269	3,373	3,477	3,582	3,686	3,790	3,894	3,998	4,102	4,206	4,310	4,414
34	2,669	2,774	2,878	2,983	3,088	3,193	3,297	3,402	3,507	3,612	3,717	3,821	3,926	4,031	4,136	4,240	4,345	4,450
36	2,693	2,798	2,904	3,009	3,115	3,220	3,326	3,431	3,537	3,642	3,748	3,853	3,958	4,064	4,169	4,275	4,380	4,486
38	2,717	2,823	2,929	3,035	3,142	3,248	3,354	3,460	3,566	3,672	3,778	3,885	3,991	4,097	4,203	4,309	4,415	4,521
40	2,741	2,848	2,955	3,062	3,168	3,275	3,382	3,489	3,596	3,703	3,809	3,916	4,023	4,130	4,237	4,344	4,450	4,557

Table 1. Filling pressure as a function of the temperature

Tab. 1

Temp [°C]	4,3	4,4	4,5	4,6	4,7	4,8	4,9	5,0	5,1	5,2	5,3	5,4	5,5	5,6	5,7	5,8	5,9	6,0
-26	3,463	3,547	3,631	3,716	3,800	3,884	3,969	4,053	4,137	4,221	4,306	4,390	4,474	4,559	4,643	4,727	4,812	4,896
-24	3,499	3,584	3,669	3,754	3,839	3,924	4,009	4,094	4,179	4,264	4,349	4,434	4,519	4,604	4,689	4,774	4,859	4,944
-22	3,536	3,621	3,707	3,793	3,878	3,964	4,050	4,135	4,221	4,307	4,392	4,478	4,564	4,649	4,735	4,821	4,906	4,992
-20	3,572	3,658	3,745	3,831	3,917	4,004	4,090	4,176	4,263	4,349	4,435	4,522	4,608	4,694	4,781	4,867	4,954	5,040
-18	3,608	3,695	3,782	3,869	3,956	4,044	4,131	4,218	4,305	4,392	4,479	4,566	4,653	4,740	4,827	4,914	5,001	5,088
-16	3,645	3,732	3,820	3,908	3,996	4,083	4,171	4,259	4,346	4,434	4,522	4,610	4,697	4,785	4,873	4,960	5,048	5,136
-14	3,681	3,770	3,858	3,946	4,035	4,123	4,212	4,300	4,388	4,477	4,565	4,654	4,742	4,830	4,919	5,007	5,095	5,184
-12	3,718	3,807	3,896	3,985	4,074	4,163	4,252	4,341	4,430	4,519	4,608	4,697	4,786	4,876	4,965	5,054	5,143	5,232
-10	3,754	3,844	3,933	4,023	4,113	4,203	4,293	4,382	4,472	4,562	4,652	4,741	4,831	4,921	5,011	5,100	5,190	5,280
-8	3,790	3,881	3,971	4,062	4,152	4,243	4,333	4,423	4,514	4,604	4,695	4,785	4,876	4,966	5,057	5,147	5,237	5,328
-6	3,827	3,918	4,009	4,100	4,191	4,282	4,374	4,465	4,556	4,647	4,738	4,829	4,920	5,011	5,103	5,194	5,285	5,376
-4	3,863	3,955	4,047	4,139	4,230	4,322	4,414	4,506	4,598	4,689	4,781	4,873	4,965	5,057	5,148	5,240	5,332	5,424
-2	3,900	3,992	4,085	4,177	4,270	4,362	4,455	4,547	4,640	4,732	4,824	4,917	5,009	5,102	5,194	5,287	5,379	5,472
0	3,936	4,029	4,122	4,215	4,309	4,402	4,495	4,588	4,681	4,775	4,868	4,961	5,054	5,147	5,240	5,334	5,427	5,520
2	3,972	4,066	4,160	4,254	4,348	4,442	4,536	4,629	4,723	4,817	4,911	5,005	5,099	5,193	5,286	5,380	5,474	5,568
4	4,009	4,103	4,198	4,292	4,387	4,481	4,576	4,671	4,765	4,860	4,954	5,049	5,143	5,238	5,332	5,427	5,521	5,616
6	4,045	4,140	4,236	4,331	4,426	4,521	4,617	4,712	4,807	4,902	4,997	5,093	5,188	5,283	5,378	5,474	5,569	5,664
8	4,082	4,177	4,273	4,369	4,465	4,561	4,657	4,753	4,849	4,945	5,041	5,137	5,232	5,328	5,424	5,520	5,616	5,712
10	4,118	4,215	4,311	4,408	4,504	4,601	4,698	4,794	4,891	4,987	5,084	5,180	5,277	5,374	5,470	5,567	5,663	5,760
12	4,154	4,252	4,349	4,446	4,543	4,641	4,738	4,835	4,933	5,030	5,127	5,224	5,322	5,419	5,516	5,613	5,711	5,808
14	4,191	4,289	4,387	4,485	4,583	4,681	4,779	4,876	4,974	5,072	5,170	5,268	5,366	5,464	5,562	5,660	5,758	5,856
16	4,227	4,326	4,424	4,523	4,622	4,720	4,819	4,918	5,016	5,115	5,214	5,312	5,411	5,509	5,608	5,707	5,805	5,904
18	4,264	4,363	4,462	4,562	4,661	4,760	4,860	4,959	5,058	5,157	5,257	5,356	5,455	5,555	5,654	5,753	5,853	5,952
20	4,300	4,400	4,500	4,600	4,700	4,800	4,900	5,000	5,100	5,200	5,300	5,400	5,500	5,600	5,700	5,800	5,900	6,000
22	4,336	4,437	4,538	4,638	4,739	4,840	4,940	5,041	5,142	5,243	5,343	5,444	5,545	5,645	5,746	5,847	5,947	6,048
24	4,373	4,474	4,576	4,677	4,778	4,880	4,981	5,082	5,184	5,285	5,386	5,488	5,589	5,691	5,792	5,893	5,995	6,096
26	4,409	4,511	4,613	4,715	4,817	4,919	5,021	5,124	5,226	5,328	5,430	5,532	5,634	5,736	5,838	5,940	6,042	6,144
28	4,446	4,548	4,651	4,754	4,857	4,959	5,062	5,165	5,267	5,370	5,473	5,576	5,678	5,781	5,884	5,987	6,089	6,192
30	4,482	4,585	4,689	4,792	4,896	4,999	5,102	5,206	5,309	5,415	5,516	5,620	5,723	5,826	5,930	6,033	6,137	6,240
32	4,518	4,623	4,727	4,831	4,935	5,039	5,143	5,247	5,351	5,455	5,559	5,663	5,768	5,872	5,976	6,080	6,184	6,288
34	4,555	4,660	4,764	4,869	4,974	5,079	5,183	5,288	5,393	5,498	5,603	5,707	5,812	5,917	6,022	6,126	6,231	6,336
36	4,591	4,697	4,802	4,908	5,013	5,119	5,224	5,329	5,435	5,540	5,646	5,751	5,857	5,962	6,068	6,173	6,279	6,384
38	4,628	4,734	4,840	4,946	5,052	5,158	5,264	5,371	5,477	5,583	5,689	5,795	5,901	6,007	6,114	6,220	6,326	6,432
40	4,664	4,771	4,878	4,985	5,091	5,198	5,305	5,412	5,519	5,625	5,732	5,839	5,946	6,053	6,160	6,266	6,373	6,480

## 3. Maintenance

Maintenance includes the following simple inspections and operations:

- **Every 6 Months:** visually inspection of the components;
- **Every 5 Years:** gas humidity check; alarm check and block contact operations for low gas pressure check

### 3.1. Pressure check and gas adding

If the pressure is lower than the rated value, add gas as indicated in “gas filling”, section 2.8.

In the case the pressure has decreased as a function of the service temperature, you must check any potential gas leakage with a detector.

### 3.2. Visual Inspection

The transformer requires ordinary external cleaning depending on the environmental conditions and according to the established cleaning cycle for other station apparatus (circuit breakers, disconnectors, etc.). In general, an external inspection is enough to check the condition of the equipment. While operating, deposits (dust, soot, salt, etc.) could form on the surface. Special cleaning systems or devices are not required and it can be cleaned like other similar equipment.

### 3.3. Gas Humidity Check

Gas humidity is checked by connecting the hygrometer to the gas filling valve. The humidity content must be less than 500 ppm vol., after the erection (one week after filling). Then repeat the measurement every 5 years. The value should be less than 500 ppm vol. If the measured values are higher than the allowed ones, notify it to ABB.

### 3.4. Moving VT after the erection

If it is necessary to move a transformer that is already in working conditions (or with a rated internal pressure), the instructions on the nameplate must be followed: maximum pressure for the transport is 0.03 MPa at 20°C.. The internal pressure decreases, using the inlet valve, until the indicated value is reached; it must not be less than atmospheric pressure.

Gas can't be dissipated in the environment. Gas must be recovered according to the normative IEC62271.

The recovered gas could be re-used according to the standard IEC60480, after the gas purification and drying process. Move the transformer as indicated in the paragraph “Moving”. When the transformer has been positioned at the operating site, repeat the filling procedure indicated in paragraph “Gas Filling”.



**Warning: always use SF6 gas which conforms with IEC60376 standard. The VT gas compartment cannot be open or evacuated without asking to the supplier.**

### 3.5. Spare Parts

It is not necessary to provide spare parts. Tools (a set of wrenches and screwdrivers) and special equipment (connecting hose and pressure reducer) for gas filling are necessary for installation and maintenance.

## 4. Warning

In order to avoid potentially dangerous situations:

- Check that the shock/overturning indicator didn't operated during the transport
- Do not perform any operation that is not described in this Manual
- Connect to earth one terminal of each secondary winding
- Move, transport or store the equipment only with 0,03 Mpa internal gas pressure, in vertical position and only in the directions indicated.

## Notes

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[illegible]

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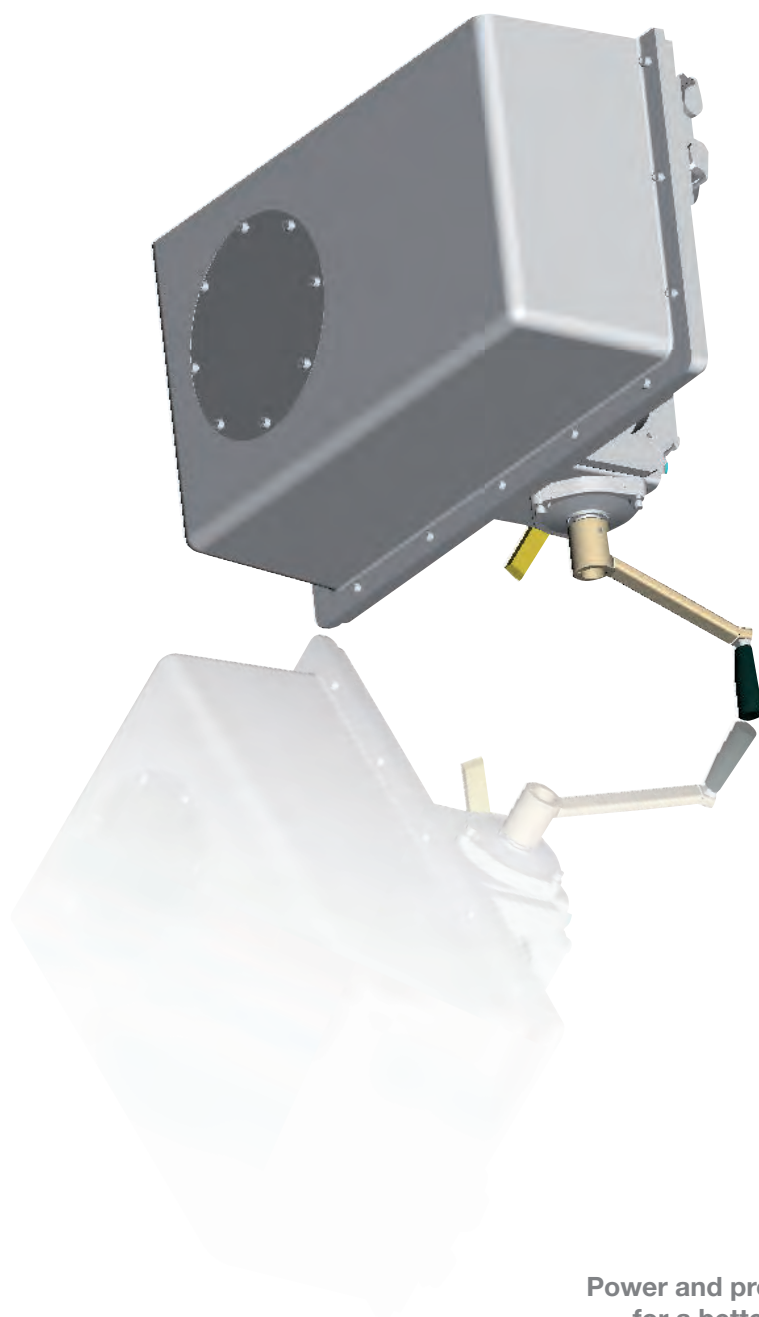
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# DISCONNECTOR DRIVE BES7 and linkages



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# 1. General Description



NOTE: pictures shown in this document are to be considered as an example.  
Specific arrangements on project can be different.

## 1.1 Main Components

The following components are present in any variant of Disconnector Drive.

The BES7 disconnector drive is a manual and electrical drive for the combined disconnectors/earthing switch for multifunctional equipments like PASS and GIS.

The same drive is applicable for different disconnector arrangement: single busbar, double busbar, line or cable disconnector, slow earthing switch, fast earthing switch and rotating chamber.

Each application is characterized by small design variants on the support structure, signalling device and interlock system which are described in the dedicated documentation.

### Legenda:

- |    |                      |    |                                       |
|----|----------------------|----|---------------------------------------|
| 1- | Electric Motor       | 6- | Electro-magnet to handle manual drive |
| 2- | Gear Reduction Motor | 7- | Mechanical Unlock for manual drive    |
| 3- | Main Shaft           | 8- | Crank for manual operation            |
| 4- | Cover                | 9- | Electrical connectors                 |
| 5- | Position Indicator   |    |                                       |

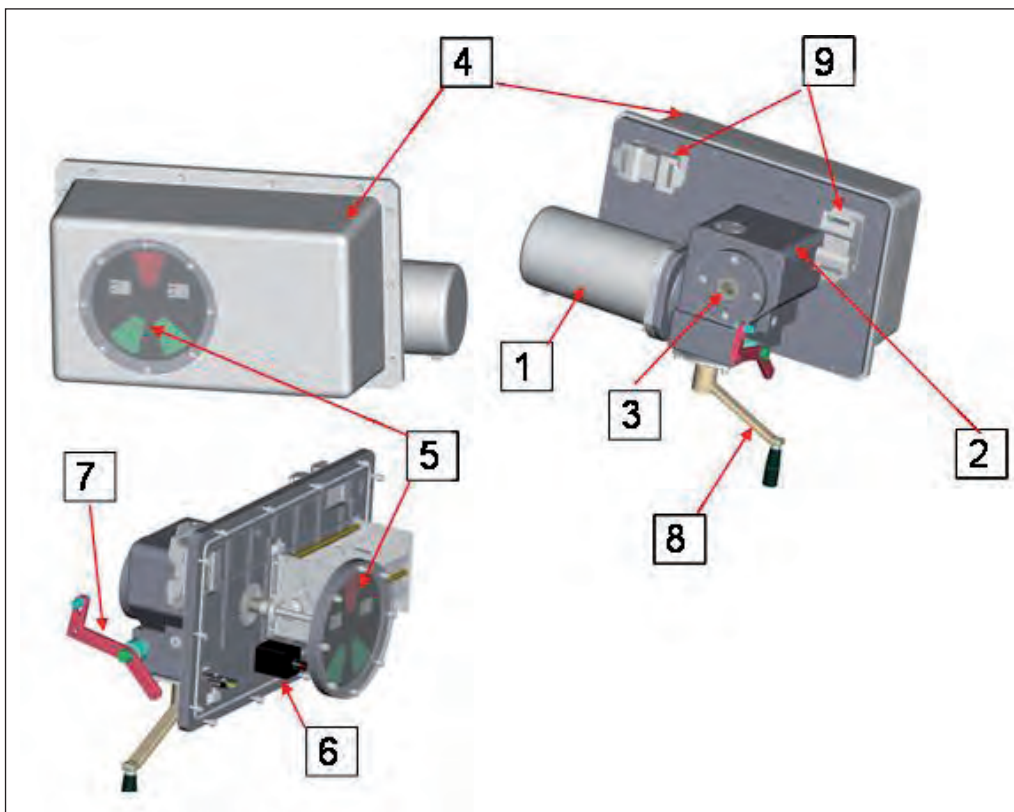
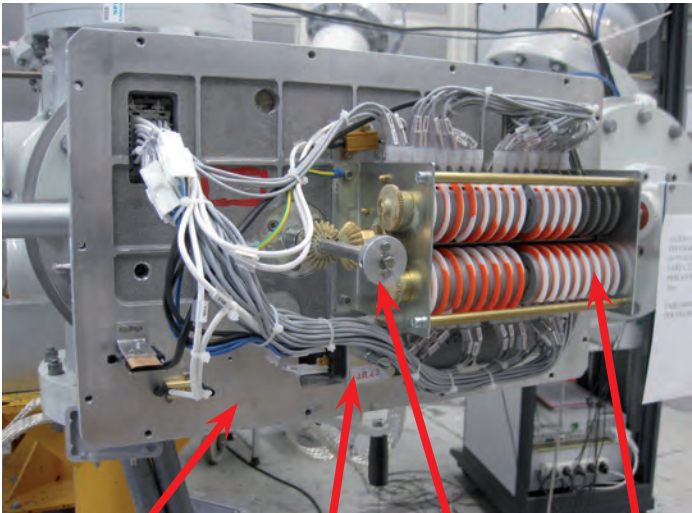


Figure 1 – Inside view of disconnecter Command



disconnecter  
command support

Unlocking coil for  
manual operation

Signaling Command Shaft  
(open / close)

Auxiliary Contacts

Figure 2 – Disconnecter with the transmission in the transport position

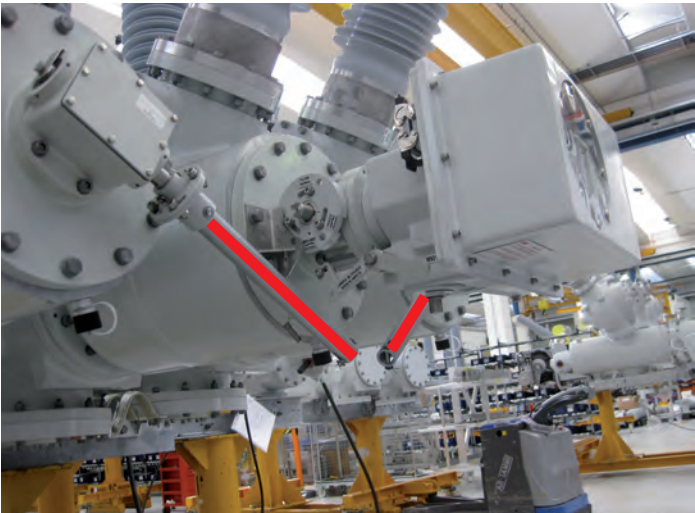
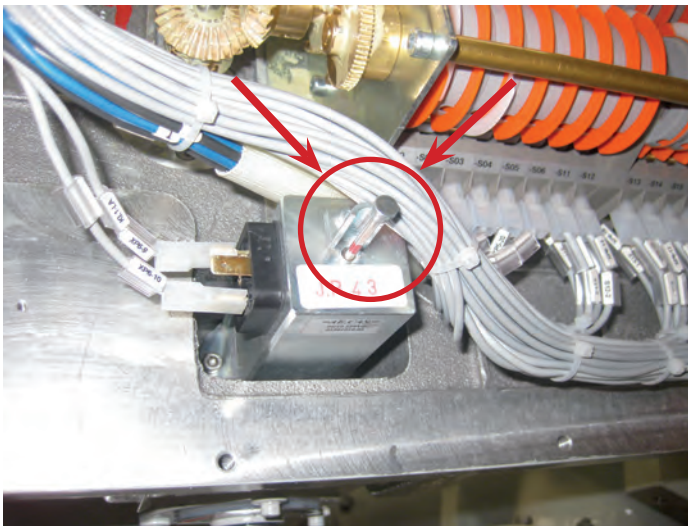


Figure 3 – Application of disconnecter command on the lateral pole



Figure 4 – Unlocking pin of the coil for the manual operation



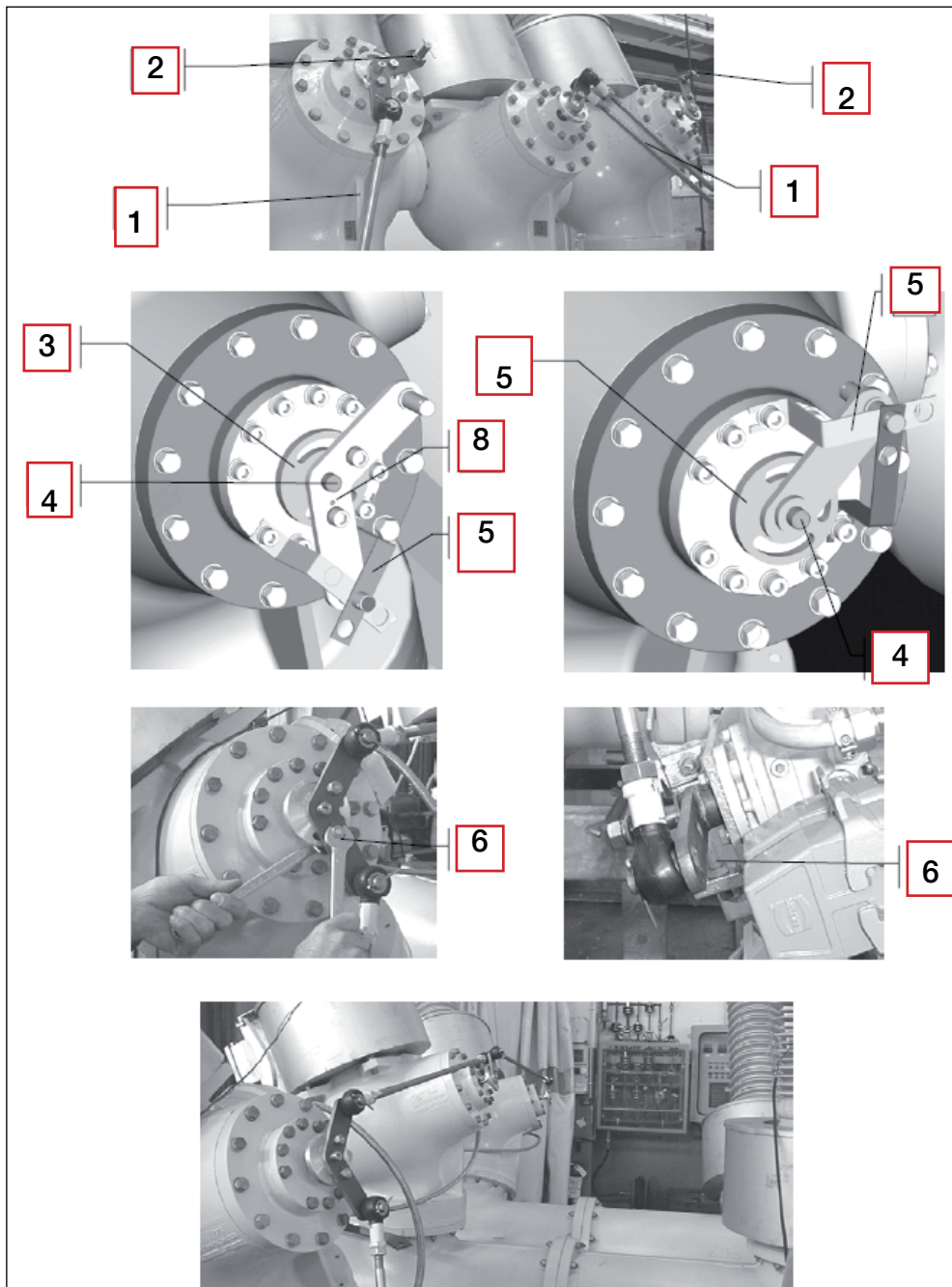


## 1.2 Mechanical Coupling BES7

Once the side poles have been rotated to the final installation position, the BES7 transmissions have to be coupled:

- 1) the rods (1) have to be coupled with their pins; the regulation flanges (3) should be kept fixed, preventing them to rotate from the original position around the shaft(4); remove the locking transport implements(5);
- 2) move the disconnector in line-position, with the driving lever in end-stroke position (7);
- 3) Verify through the inspection window that the disconnector moving contacts are equally inserted in their fixed contacts; if necessary loosen the two nuts (6) of the relevant contact, and rotate the regulation flange (3) to achieve the correct positioning. Tighten the two nuts (6);
- 4) With a manual operation close the disconnector in the earth position and verify, in the same way, all moving contacts are equally inserted in their fix contacts; if necessary, adjust as described above.
- 5) With a drill Ø5 (+0 / +0,12) drill the flange (3) directly from the prehole above the lever (8) and afterwards insert the elastic plug provided with the scope of supply.

Figure 5 - mechanical coupling BES7



# 2. Operation

## 2.1 Electrical Operation

In general it is possible to electrically operate the drive only when the circuit breaker is open; in case of line/ earthing switches the standard schematic diagram includes an external interlock to allow the earthing (e.g. consensus from external voltage transformers).

The specific schematic diagram reports the operating conditions of the mechanism.

When the open/close buttons are pressed on the local control cabinet or from remote, with the relevant consensus of the S43 selector in the control cabinet, the motor rotates and, by means of gear reduction motor, causes the rotation of the main shaft of the mobile contact inside the disconnecter.

**Fig. 6 Disconnecter S43 in different positions**



**S43 in Remote position**



**S43 in Local position**



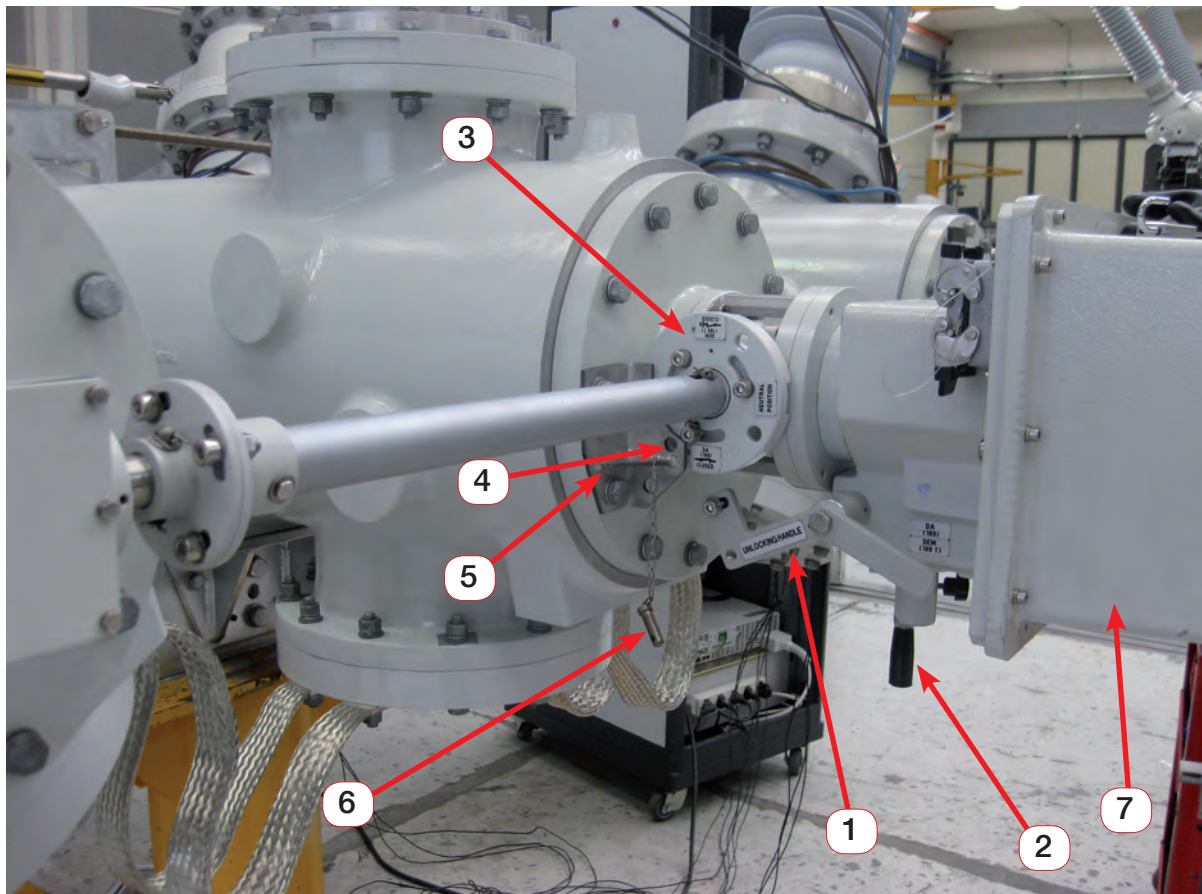
**S43 in Manual position**

## 2.2 Manual Operation (fig.7 – 7bis)

For manual operation (emergency or maintenance) the electromagnet (6) must be energized; this is achieved by turning the relevant selector on the control cabinet on “Manual” position. In general the circuit breaker must be open and the consensus from external interlocks is required. The specific schematic diagram reports the operating conditions of the mechanism.

Pull the mechanical unlock lever (1), inserting its end into the disk (3); turn the crank (2) two turns, release the unlock lever (1) which will remain inserted into the disk (3); continue turning the crank (2) until the unlock lever (1) is released by the disk (3). Check the position reached by the disconnector on the indicator. The final correct position reached by the disk (3) is possible only when the locking pin (6) will be inserted in the relevant position (4).

**Figura 7 – Manual Block for the back disconnector drive**

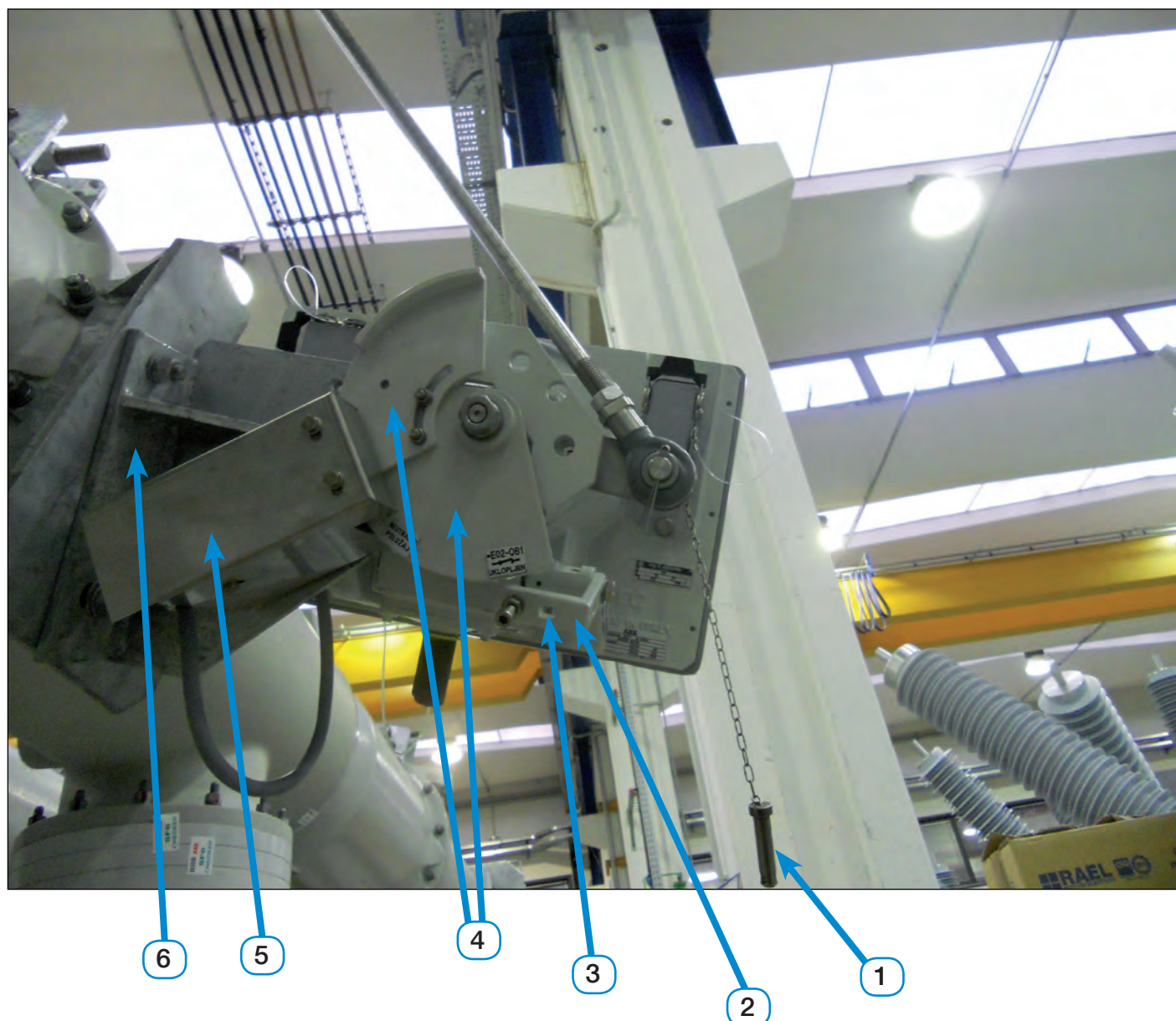


Legend:

- |    |                           |    |                |
|----|---------------------------|----|----------------|
| 1. | Mechanical Unlock Lever   | 5. | Fixing support |
| 2. | Crank                     | 6. | Blocking Pin   |
| 3. | Disk                      | 7. | Cover          |
| 4. | Hole for the blocking pin |    |                |



Figura 7 bis Manual Block for the back disconnector drive



Legend:

- |    |                           |    |   |
|----|---------------------------|----|---|
| 1. | Blocking Pin              | 5. | Security Electromagnet<br>(earthing disconnecter) |
| 2. | Unlock Lever              | 6. | Fixing Support                                    |
| 3. | Hole for the blocking pin |    |   |
| 4. | Disk                      |    |   |



During the manual operation, pay attention to the indicating plates near the crank showing the rotation way of the crank. Check always the final position on the disk (4). Check the final position by inserting the locking pin (then remove it). Any electrical operation of the CB is guaranteed only when this position is reached.





**WARNING:** In absence of auxiliary voltage and only in case of emergency it is possible to execute a manual operation of disconnector. Remove the cover (7) and manually pull the mobile pin of the release (fig.4) coil(fig. 4) to enable the movement of the release lever. Such operation shall be performed by trained personnel only, since once the electromagnet has been removed, all safety interlocks are inhibited. Such an operation is under full responsibility of user.

Legend:

Figure 8 Crank shaft

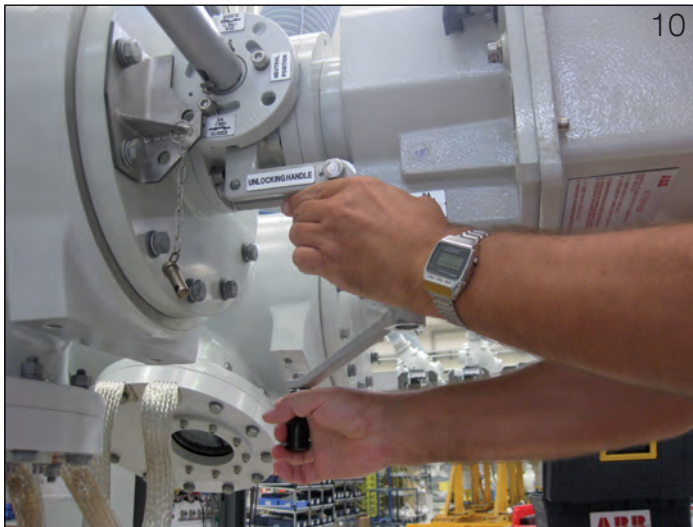
Figure 9 Hand Crank Inserted

Figure 10 Manual Operation

Figure 11- Locking Position ensured by the disconnector

Figure 12- Insertion of the Blocking Pin

Figure 13- Padlock position



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**COMBINED  
DISCONNECTING  
SWITCHES FOR  
PASS – MCI  
145/170 kV MODULES**

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## 1. General

PASS - MCI modules are fitted with combined disconnecting switches with three separated poles isolated in SF<sub>6</sub>, connected with the electro-mechanical command BES7, using mechanical transmissions (for further information, see the relevant manual Doc.2GJA708354). The design of the poles enables several uses with straight or inclined layout. The functional features between the two types of disconnecting switch are identical. The choice of using one straight disconnecting switch instead of an inclined one depends on the layout of the module and on the type of input/output: SF6 /air, SF6 /cable or duct.

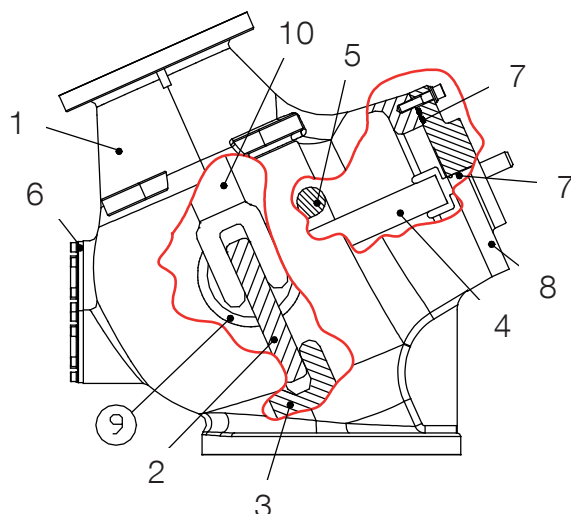


Fig. 1 Inclined combined disconnecting switch

## 2. Description of the combined disconnecting switch

### 2.1. Enclosure

It is made of an enclosure (1) in aluminum alloy: its shape varies according to the assembly layout (straight or inclined).

### 2.2. Active Parts

They include: Fixed contacts (3), with relating supports. A rotating isolator (4). A movable contact (1).

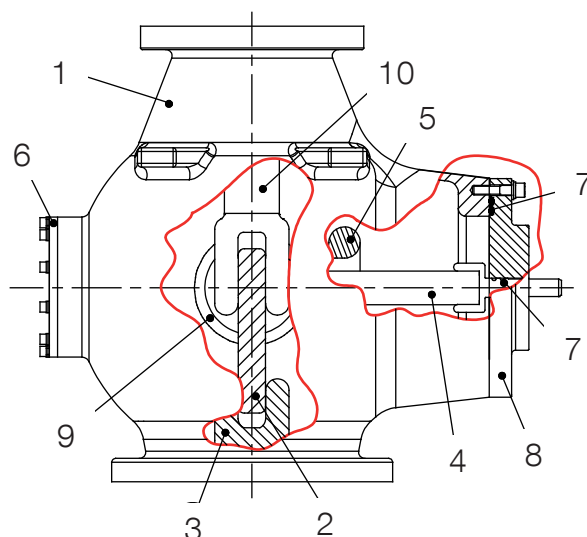
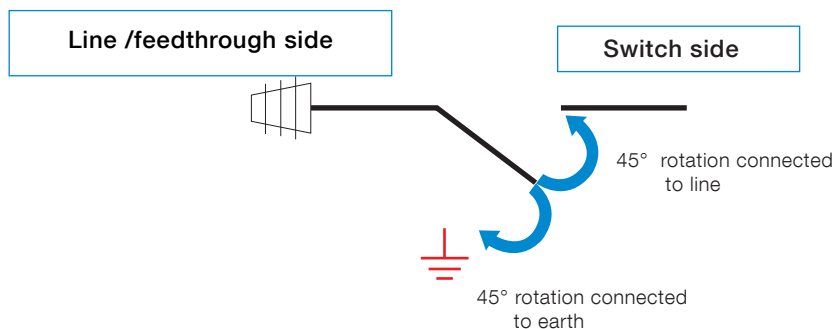


Fig. 2 Straight combined disconnecting switch



Operation diagram of the combined earthing switch

#### KEY (fig. 3):

1. Enclosure
2. Movable contact
3. Fixed contact
4. Rotating isolator
5. Shield
6. Inspection window
7. Gaskets
8. Cover
9. Earthing cover
10. Movable contact support



### 3. Operation of the combined disconnecting Switch

The operating principle is based on the rotation of the rotating isolator (4) pulled by a transmission group connected to the electro-mechanical command BES7. The position of the combined earthing switch is always clearly indicated through an indicator applied onto command BES7. In the starting position the disconnecting switch is open (neutral) with a 45° rotation which closes the line disconnecting switch. With a 45° rotation in the opposite direction the earthing connection is made. Inspection windows are assembled on the enclosure of each pole.

### 4. Combined disconnecting switch type 6

The operating principle of the combined disconnecting switch type 6, is different from the “standard” combined disconnecting switch (explained earlier) because the closing operation of the earthing switch creates the earth connection in the opposite way, that is: the standard earths line side / feedthrough, type 6 earths the switch side. In the starting position the disconnecting switch is open (neutral) with a 45° rotation of the rotating isolator (4) pulled by a transmission group connected to the electromechanical command BES7, the line disconnector is closed. With a 45°, in the opposite direction, the earth connection is made. Inspection windows are fitted on each pole to see the disconnection.

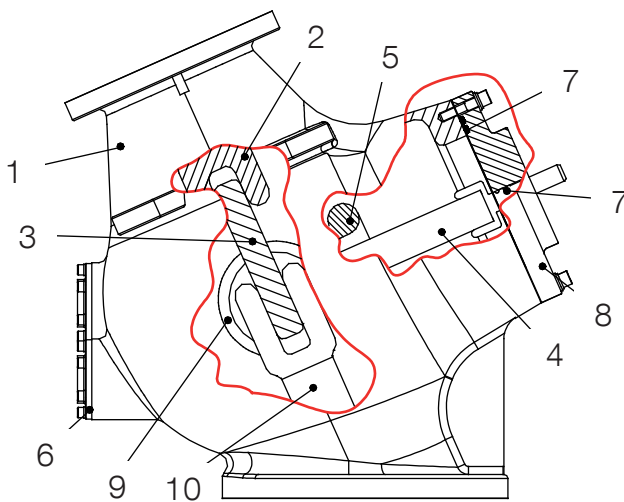
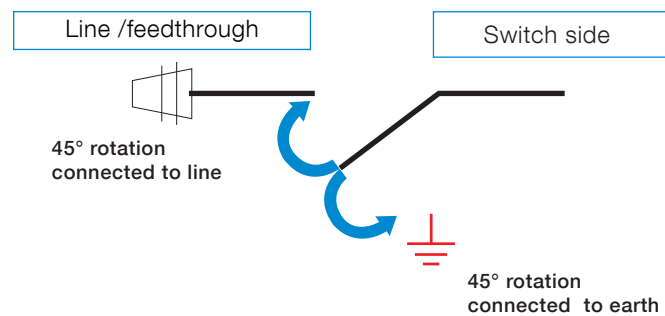


Fig. 3 Combined disconnecting switch type 6

KEY (fig. 3):

- 1. Enclosure
- 2. Movable contact
- 3. Fixed contact
- 4. Rotating isolator
- 5. Shield
- 6. Inspection window
- 7. Gaskets
- 8. Cover
- 9. Earthing cover
- 10. Movable contact support



Operation diagram of the combined earthing switch type 6

## 5. Description of the single bar disconnector

### 5.1. Enclosure

It is made of the same enclosure (1) of the switch, in aluminum alloy.

### 5.2. Active Parts

They include:

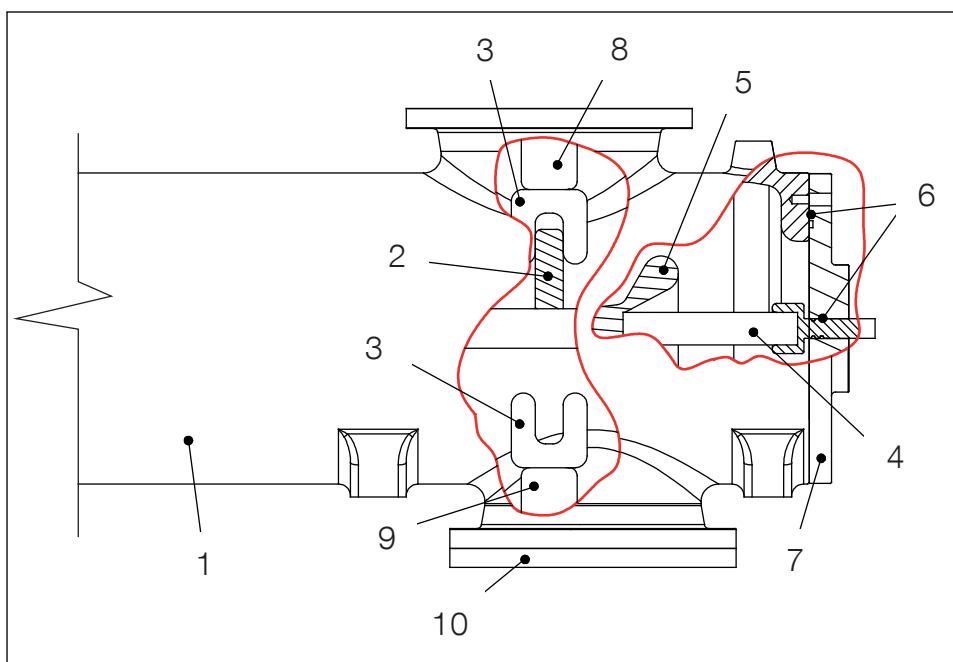
A fixed contact (3), with relating supports.

A rotating isolator (4).

A movable contact (2)

## 6. Operating of the single bar disconnector

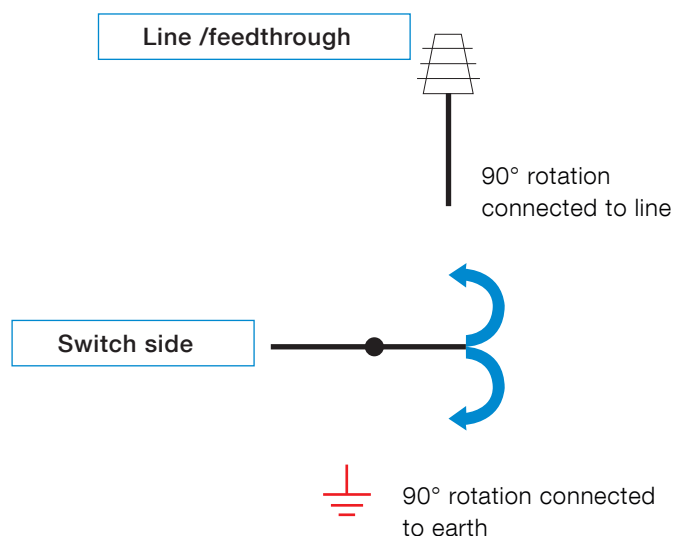
The operating principle is based on the rotation of the rotating isolator (4) pulled by a transmission group connected to the electro-mechanical command BES7. The position of the combined earthing switch is always clearly indicated through an indicator applied onto command BES7. In the starting position the disconnecting switch is open (neutral) with a 90° rotation which closes the disconnecting switch, with a 90° rotation in the opposite direction (starting from the neutral position) the earthing connection is made.



KEY (fig. 3):

- 1. Enclosure
- 2. Movable contact
- 3. Fixed contact
- 4. Rotating isolator
- 5. Isolating shield
- 6. Gaskets
- 7. Cove
- 8. Fixed contact support
- 9. Earth contact support
- 10. Earthing cover

Fig. 4 Single bar disconnector



Operating diagram of single bar disconnector



## 7. Description of the angle disconnecting switch

### 7.1. Enclosure

It is made of an enclosure (1) in aluminum alloy.

### 7.2 Active parts

They include:

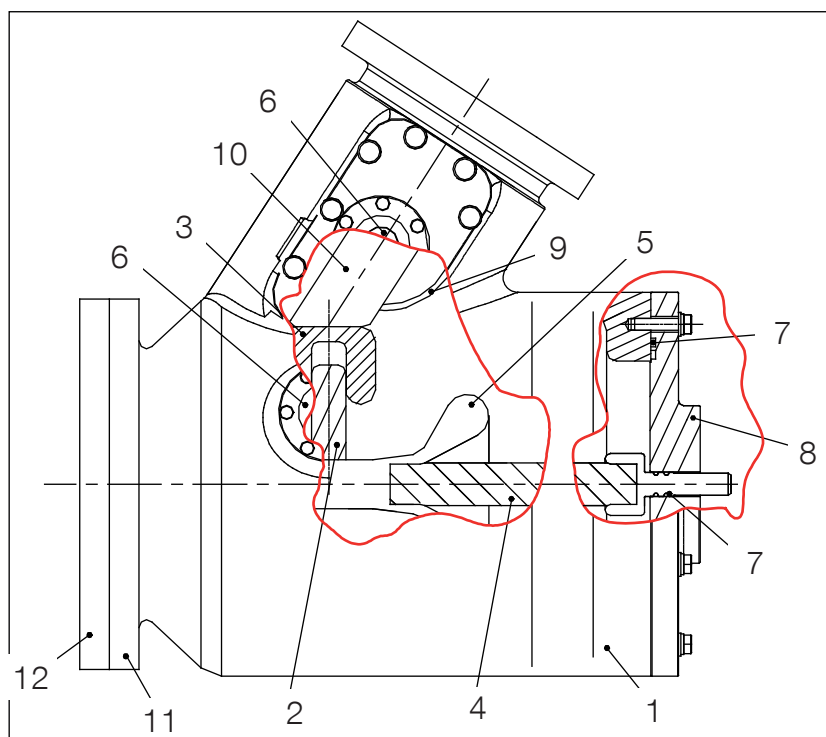
A fixed contact (3), with supports.

A rotating isolator (4).

A movable contact (2).

## 8. Operation of the angle disconnecting switch

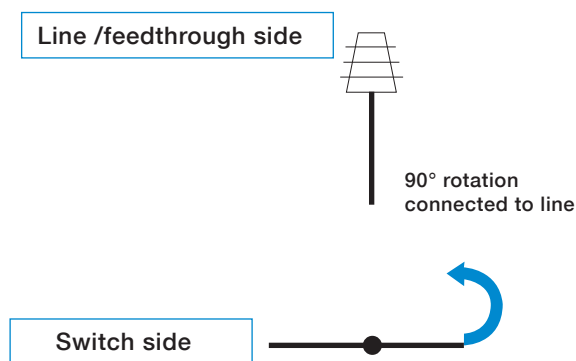
The operating principle is based on the rotation of the rotating isolator (4) pulled by a transmission group connected to the electro-mechanical command BES7. In the starting position the disconnecting switch is open, with a 90° rotation the line/bar disconnecter is closed.



KEY (fig. 5):

- 1. Enclosure
- 2. Movable contact
- 3. Fixed contact
- 4. Rotating isolator
- 5. Isolating shield
- 6. Inspection window
- 7. Gaskets
- 8. Cover
- 9. Earthing cover
- 10. Fixed contact support
- 11. Flanges
- 12. Isolating disc

Fig. 5 Angle disconnecting switch



Operating diagram of angle disconnecting switch

## Notes

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Doc. 2GJA700269  
Rev. C 02/2013 [LM]  
Title:  
Rupture Disc

# RUPTURE DISC

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# 1. Rupture Disc

## 1.1. Description (fig. 1)

The rupture disc (or membrane) consists of a convex metal plate, pressed gas tight between two flanges, and constitutes a separating barrier between the gas compartment and the atmosphere. It has special rupture points that break when the bursting pressure is reached.

The safety device consists mainly of (figure 1):

- a ring (1) which constitutes the seat of the disc;
- the disc itself (5);
- a protective shield (3) suitably oriented according to its assembly, to avoid the risk of injury or damage to persons or equipment if the disc opens;
- a protective lid (4) which blocks the expulsion of solid particles and a vermin guard (6) which keeps insects out.



**WARNING:** whenever the safety device has to be removed, it must be replaced together with its seals

## 1.2. Package

Each rupture disc is packaged individually in polystyrene containers (as spare part). The bursting pressure and manufacturing number are indicated externally on its side.

## 1.3. Rupture disc replacement (fig.1)

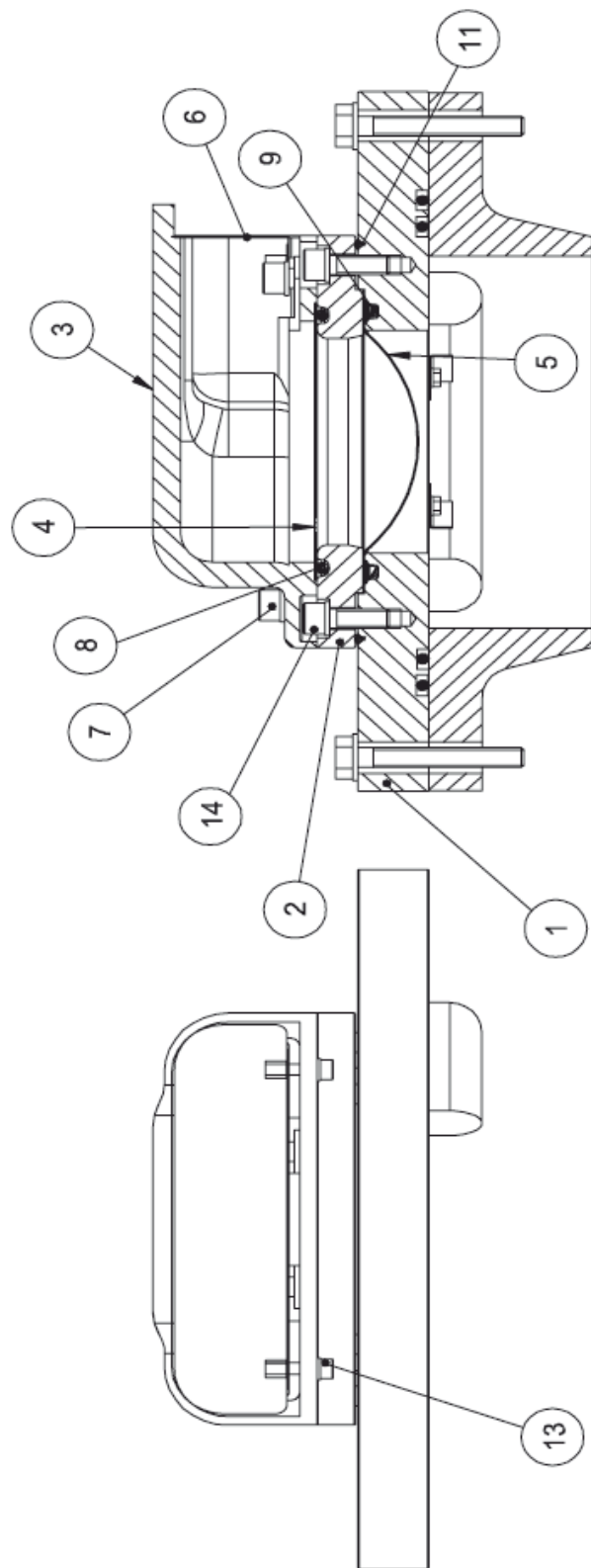
The rupture disc device is completely assembled at the factory and it is only to be replaced in the case of servicing or overhauling. To replace it, proceed as follows:

- remove the vermin guard (6) by loosening the two M6 screws (13);
- remove the four M12 screws (7), with torque 4.8 daNm and remove the protective shield (3) and the protective lid (4);
- remove the n.8 M12 screws (14) that secure the flange (2), with a torque of 4.8 daNm;
- remove the ring (1), the disc (5) and the seals (9) and (11); - replace the disc (5) with its seals (9), (11) and (8);
- having cleaned the surfaces of the seals thoroughly and greased them slightly, assemble by following the reverse of the steps described above;
- insert the new disc with its convex side facing towards the inside of the gas compartment;
- assemble the flange (2) with the screws (14) tightening them alternately in a cross arrangement, applying the specified torque;
- centre the protective lid (4) so that, when the screws are tightened, only the rim is pressed (no other part of the protective lid must be pressed).

## 1.4. Control

The only checks during exercise is required molecular gas SF6 through tool.

figure 1 Rupture Disc



Legend:

- |                      |           |
|----------------------|-----------|
| 1. ring              | 7. screw  |
| 2. flange            | 8. seal   |
| 3. protective shield | 9. seal   |
| 4. protective lid    | 11. seal  |
| 5. rupture disk      | 13. screw |
| 6. protective plate  | 14. screw |

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RESISTANCE CLASS	3,6	4,6	5,6	5,8	6,8	8,8	10,9
ELASTIC LIMIT	19,6	23,5	29,4	39,2	47	62,7	88,2
M Ø x PITCH							
M 4 x 0,7	0,8	1	1,3	1,7	2,1	2,8	4
<b>M 5 x 0,8</b>	1,7	2	2,6	3,5	4,2	5,6	7,9
<b>M 6 x 1</b>	3	3,6	4,5	6	7,2	9,6	13,5
M 8 x 1	7,8	9,4	11,7	15,6	18,8	25	35
<b>M 8 x 1,25</b>	7,3	8,7	10,9	14,5	17,4	23,2	33
M 10 x 1	16,4	19,7	24,6	33	39	52	74
M 10 x 1,25	15,5	18,6	23,2	31	37	50	70
<b>M 10 x 1,5</b>	14,6	17,5	21,9	29,1	35	47	66
M 12 x 1	28,8	35	43	58	69	92	130
M 12 x 1,25	27,5	33	41	55	66	88	124
<b>M 12 x 1,75</b>	24,9	30	37	50	60	80	112
M 14 x 1,5	44	54	67	88	106	135	195
M 14 x 2	40	48	60	80	95	127	179
M 16 x 1,5	66	79	99	131	158	210	296
<b>M 16 x 2</b>	61	73	92	122	147	196	275
M 18 x 1,5	96	128	160	193	230	310	430
M 18 x 2	94	119	155	181	205	300	378
M 18 x 2,5	89	115	149	172	197	290	365
M 20 x 1,5	134	160	200	267	320	430	600
M 20 x 2	127	152	190	253	300	400	570
<b>M 20 x 2,5</b>	120	143	179	239	287	380	540
M 22 x 1,5	200	260	320	360	430	570	800
M 22 x 2,5	180	220	280	320	390	520	720
M 24 x 2	227	272	340	450	540	730	1020
<b>M 24 x 3</b>	207	248	310	410	500	660	930
M 30 x 2	460	550	690	920	1110	1480	2080
M 30 x 3,5	410	500	620	830	990	1320	1860

### Notes

THE VALUE OF THE DRIVING TORQUE IS CALCULATED AT 3/4 OF THE ELASTIC LIMIT OF THE SCREW.

FRICITION FACTOR: ON WASHER 0,13; ON THREADS 0,15

FOR STAINLESS STEEL BOLTS REFER TO RESISTANCE CLASS = 5.6

FOR HOT GALVANIZED STEEL BOLTS REFER TO RESISTANCE CLASS = 8.8

FOR FIXING WITH ALUMINUM SCREW (CLOSING FLANGES, BLOCKS, ETC...)

REFER TO RESISTANCE CLASS = 5.8 - 6.8

FOR FIXING WITH METAL FLANGES WITH EPOXY RESIN INSULATOR

(DISC INSULATOR, PLUG IN CABLE END) REFER TO CLASS = 4.6 - 5.6

DILO COUPLING FROM 3/8" IN ENCLOSURE = 40 NM (ALUMINUM) / 60 NM (STEEL)

DILO COUPLING FROM 1" IN ENCLOSURE = 90 NM (ALUMINUM) / 110 NM (STEEL)

COUPLING OF SPRING BODY OR PROTECTION CAP: DN 8 = 60 Nm / DN 20 = 70 Nm

FOR FEEDTHROUGH HOLD: M30 HOLD D40 = 300 NM; M30 HOLD D30 (WITH BLOCKING FLANGE) = 280 NM

M30 HOLD D30 = 200 NM

REPLACE UA412925

Doc. 2GJA708385

Rev. B 02/2013 [LM]

Title:

End of life Equipment Treatment Pass - MCI - BLF/PASS

# **END OF LIFE EQUIPMENT TREATMENT PASS - MCI - BLF/PASS**

## End of life Equipment Treatment Pass - MCI - BLF/Pass

### Contents

1. END OF LIFE TREATMENT	3
1.1 Metallic oxide varistor (only if overvoltage arresters are present)	3
2. CHART AND MATERIALS WITH "CER" CODE	4
2.1 SF6 Isolating gas (sulphur hexafluoride)	5

# 1. End of life treatment

Module type PASS – MCI – BLF/PASS are products that must be disposed of in accordance with the laws in force in the installation Country. The materials that form the hybrid and metal-clad equipment can be recycled.

The main components are:

- Enclosures of the aluminum alloy modules.
- Switch /disconnectors commands (carbon steel/ aluminum/copper).
- Current transformers (stainless steel, silicon steel, copper, epoxy resin).
- Voltage transformers (aluminum alloy, silicon steel, copper, epoxy resin).
- Metal structures and module stands in carbon steel. · Internal copper and aluminum parts.
- Bushing SF6/Air, made of an internal cylinder in epoxy resin and covered in silicon rubber.
- Compartmenting discs or epoxy resin stand · Isolating gas SF6 (sulphur hexafluoride).
- Copper connection cables with PVC sheaths.
- Nitril gaskets (NBR) or ethyl- propylene (EPDM).
- Module cabinet with relays and low voltage cables.  
Accessories:
- Inspection window (sodium calcium tempered glass).
- Break disc (monel).
- Arc sensor base (if present) (aluminum alloy).
- Gas density gauge (stainless steel, brass, polycarbonate).
- Connection valves – topping up - control DN8 / DN20 (aluminum alloy).
- Accessory parts and steel and stainless steel nuts and bolts.

## 1.1 Metallic oxide varistor (only if surge arresters are present)

Metallic oxide varistors are in sintered ceramic made for 90% of ZnO. The following components are also contained:

- Percentage per weight over 1%: Bi<sub>2</sub>O<sub>3</sub> e Sb<sub>2</sub>O<sub>3</sub>, which have been considered dangerous substances according to EU standards.
- Percentage per weight between 0.1 and 1%: NiO and Cr<sub>2</sub>O<sub>3</sub>, which have been considered toxic and dangerous materials in accordance with EU Directive 91/689/EEC.

Metallic oxide varistors are covered with a thin layer of glass containing lead oxide ( < 0.1% of the weight).

The substances are present as oxide in metallic oxide varistors. An elimination test carried out according to the EPA specification (Federal Register vol. 45, N. 98 Rules and regulations ) showed that sintered metallic oxide varistors can be disposed of as industrial waste without violating the EC standards.

## 2. Chart and materials with “CER” Code

List of materials used for the classification according to the C.E.R. code (Legislative Decree n. 152 of 3 April, 006, including the “Environmental standards”, and following integrative modifications).

- Communication of the Ministry for the Environment published on the Official Gazette n. 146 of 26 June, 2006 and following integrative modifications.

MODULE: Material	Cod. CER
Aluminum + its alloys	17 04 02
Fiberglass	10 11 03
Copper	17 04 01
Steel	17 04 05
Teflon	17 06 02
Glass	16 01 20
Brass	17 04 01
Nitril rubber	07 02 99
Nitrogen	16 05 01
SF6	16 05 01

Cabinet Material	Cod. CER
Steel	17 04 05
Electric cable	17 04 08
Electric equipment	16 02 02
Copper	17 04 01

PACKAGING Material	Cod. CER
Wood	15 01 03
Polyethylene	15 01 02

The weights of the materials depend on the type of product (PASS, MCI, BLF/PASS) and the station's layout.

## 2.1 SF6 Isolating gas (Sulphur Hexafluoride)



- **WARNING: SF6 ISOLATING GAS LEAK:**
- ® DO NOT discharge gas SF6 in the environment.
- ® DO NOT breath the isolating gas SF6.
- ® PREVENT insulating gas SF6 from coming into contact with skin and eyes.
- Assure the proper handling of isolating gas (see document of SF6gas system).
- Wear protective clothing according to the regulations in force.

Insulating gas SF6 must be recycled or neutralized in accordance with the normatives and laws in force in the installation Country.

## Notes

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